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SECTION 36 CONTAMINATION SURVEY

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Volume II  
March, 1985  
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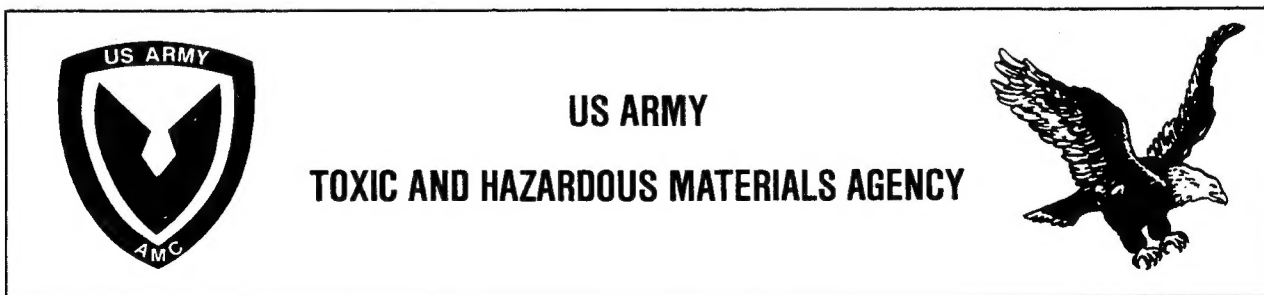
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**LITIGATION TECHNICAL SUPPORT AND SERVICES**

**Rocky Mountain Arsenal**

**Section 36 Contamination Survey**

**Technical Plan**

**Volume II**

**March, 1985**

**Contract Number DAAK11-84-0016**

**Task Number 1 (Section 36)**

**PREPARED BY**

**ENVIRONMENTAL SCIENCE & ENGINEERING, INC.**

**Harding Lawson Associates**

**Midwest Research Institute**

**PREPARED FOR**

**U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY**

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**LIST OF ACRONYMS AND ABBREVIATIONS**  
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AA	Atomic Absorption
cm	centimeters
DAR	Damage Assessment Report
CFI	Colorado Fuel and Iron Corporation
DBCP	dibromochloropropane
DCPD	dicyclopentadiene
DDT	dichlorodiphenyltrichloroethane
DIMP	diisopropylmethylphosphonate
DIW	de-ionized water
EM	Electromagnetics
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FOUO	For Official Use Only
ft	feet
ft <sup>2</sup>	square feet
g	grams
GC/MS	gas chromatography/mass spectrometry
GPR	Ground penetrating radar
HD	mustard-filled
Hg	Mercury
HLA	Harding Lawson Associates
ICAP	Inductively coupled argon plasma
in/yr	inches per year
LDC	Laboratory Data Coordinator
ml	milliliters

**LIST OF ACRONYMS AND ABBREVIATIONS**  
(Continued, Page 2 of 2)

mph	miles per hour
MRI	Midwest Research Insitute
NBS	National Institute of Health
NPS	New Project Setup
OVA	Organic vapor analyzer
PCPMSO <sub>2</sub>	p-chlorophenylmethyl sulfone
PID	photo-ionization detector
PMCDIR	Project Manager for Chemical Demilitarization and Installation Restoration
PPLV	Preliminary Pollutant Limit Value
ppm	parts-per-million
RCRA	Resource Conservation and Recovery Act
RIC	Rocky Mountain Arsenal Information Center
RMA	Rocky Mountain Arsenal
SCBA	Self-Contained Breathing Apparatus
Shell	Shell Chemical Company
µg/g	microgram/gram
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USGS	U.S. Geological Survey
UXO	unexploded ordnance
VES	Vertical Electrical Sounding
VOA	Volatile organic analysis
WP	white phosphorus

**APPENDIX A**  
**SOURCE CONDITIONS AND SOIL BORING PROGRAM**

## APPENDIX A

### Source Conditions and Soil Boring Program

#### A.0 INTRODUCTION

As summarized in Section 3.3 of this Technical Plan one purpose of the Phase I boring program is to obtain semi-quantitative information for each source to design a Phase II Program. This Appendix to the Technical Plan describes in detail specific information for each source including hydrogeologic conditions, disposal history, and results of previous geotechnical studies. This Appendix to the Technical Plan also details locations of Phase I and Phase II borings as well as depths of both Phase I and proposed Phase II borings. Phase I locations may be slightly altered as a result of site reconnaissance, the geophysical program, or other site conditions. The number, depth, and exact locations of Phase II borings may be altered as a result of interpretation of Phase I geotechnical and geochemical data.

The following discussions of specific contaminant sources include descriptions of past disposal practices, and potential contaminants. These descriptions are by source, in order, from Source 36-1' through 36-22', only for sources to be investigated during this program. The hydrogeologic condition of each source is discussed and geologic cross sections are presented. These cross-sections utilize the Unified Soil Classification System for description of stratigraphic horizons. A list of Soil Classification Symbols and their definitions is contained in Table A.0-1.

Table A.O-1. Unified Soil Classification System

---

GW -	Well graded gravel
GP -	Poorly graded gravel
GM -	Silty gravel
GC -	Clayey gravel
SW -	Well graded sand
SP -	Poorly graded sand
SM -	Silty sand
SC -	Clayey sand
ML -	Inorganic silt with very fine sand
CL -	Inorganic clay - low to medium plasticity
OL -	Organic clay
MH -	Inorganic silt
CH -	Inorganic clay - high plasticity
OH -	Organic clay - medium to high plasticity
PT -	Peat
LG -	Lignite

---

Source: ESE, 1984.



#### A.1 SOURCE 36-1': BASIN A

Basin A, which was the original disposal basin for all South Plants Area activities, has covered an area of up to 125 acres at maximum water level (Figure A.1-1). Much of the history of Basin A has been discussed in the Introduction to this Technical Plan. The original estimated extent of Basin A contamination is listed below:

Estimated Areal Extent = 5,369,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 2,289,000 yd<sup>3</sup>

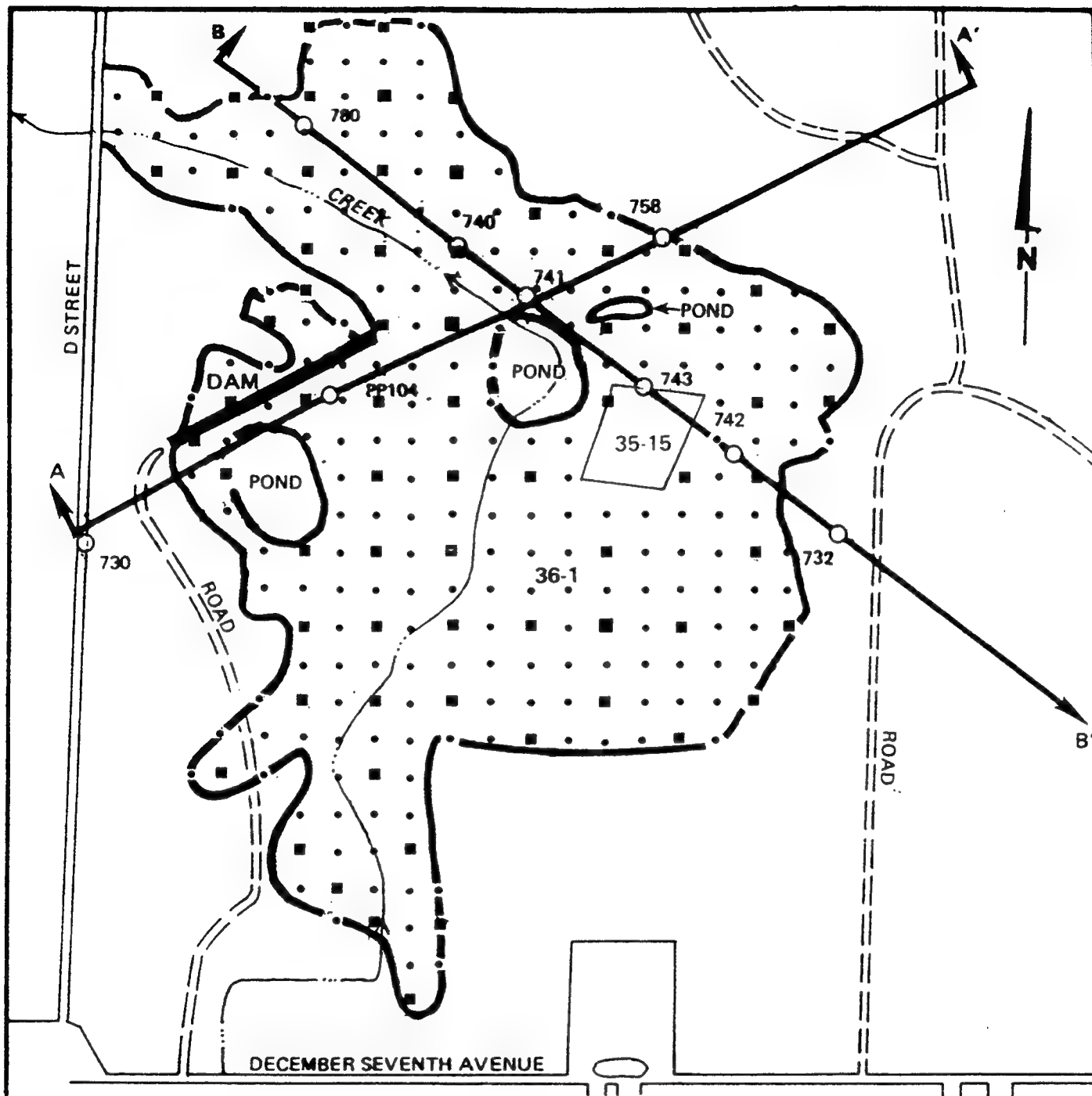
(From Rocky Mountain Arsenal Contamination Control Program Management Team - RMACCPMT, 1984)

Revised Areal Extent = 6,017,000 ft<sup>2</sup>

As a result of program changes and evaluation of background data the estimated areal extent of this source has been revised. The Mustard Plant Disposal Site 36-14 (Figure 1.2-1) is within the boundary limits of Basin A and therefore this area will be investigated as a portion of Source 36-1'. This contributes an additional 58,000 ft<sup>2</sup> in area to 36-1'. During evaluation of aerial photographic interpretations and as a result of a site reconnaissance, additional areas of suspected contamination have been identified adjacent to the original boundary of 36-1'. Therefore, these areas have been included within Source 36-1', as represented in Figure 1.2-2 and comprise a total area of 590,000 ft<sup>2</sup>. The northwest additions to 36-1' are areas where trenches and pits were observed in aerial photographs. Both southwest additions to 36-1' are locations where soils are devegetated and aerial photographs suggest these areas once contained liquids from Basin A. These locations connect the Lime Settling Pits (36-4) and Liquid Storage Pool (36-11) with Basin A. Therefore, the revised areal extent of contamination to be used in this study is 6,017,000 ft<sup>2</sup>.

#### Disposal History

Basin A received wastes and by-products from most industrial processes at RMA. Until 1956 Basin A was the primary receptor of liquid waste with overflow going to Basins C, D and E. Waste streams from the South Plants



#### EXPLANATION

- Existing Boring Locations
- Phase I Boring Locations
- Phase II Boring Locations

0 1000 2000 feet

**Figure A. 1-1**  
**BORING LOCATION MAP**  
**CONTAMINANT SOURCE 36-1'**  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

Area to Basin A were first passed through the lime settling pits to raise the pH.

Aerial photographic interpretation covering the years 1948, 1950, 1953, 1958, 1962, and 1975 reveal many changes and additions to Basin A. The 1948 photo showed a liquid basin covering 61 acres. A high water mark noted by stripped vegetation covered an area of 84 acres. This high water line partially encompassed Source 36-16, an incendiary burial site composed of 8 to 12 trenches. A small pool to the southwest of the main basin collected effluent from the lime pits before entering the main basin. This pool covered about 4.5 acres with an associated devegetated high water line covering 6 acres.

The 1950 photo showed the highest level observed in the liquid basin with a coverage of 82 acres. The associated devegetated high water line had increased to 101 acres. The small pool to the southwest had diminished in size to 3.5 acres with a devegetated high water mark covering 7 acres extending toward the lime pits. The 1953 photo showed the addition of a dam to the northwest of the main basin and a greatly reduced water level. Twenty acres were covered by water although growth of the devegetated high water line had increased to 122 acres.

The 1958 photo showed many small pools of liquid with ditches interconnecting them. The area covered by water was 19.5 acres and the devegetated high water mark had increased to 128 acres. The high water line had infringed on other sources during this time including 36-16, an incendiary burning site to the east, and 36-9, an incendiary or munitions test site to the northeast of the main basin. The small pool near the lime pits had changed shape and size and covered 3 acres. The devegetated high water line joined the main basin and lime pits and covered 17 acres. Four or more trenches were observed within the southern high water line and were considered part of source 36-14, a disposal site for material and equipment from a mustard plant.

The 1962 photo showed the main basin to be totally dry with a marked change of color to dark gray. The high water line covered 125 acres.

The water levels in the small pools near the lime pits covered 2.5 acres, and the associated disturbed/high water line covered 18 to 20 acres. Five closely spaced trenches were observed on the eastern boundary of the main basin at Source 36-16, an incendiary burial site. Six to eight trenches were located to the northwest of the basin though not all were inside the basin. Four to eight trenches were observed in one of the deep holes of Basin A and were considered Source 36-15, a burning site.

The 1975 photo showed the most change and disturbances observed. Water in three small- to medium-sized pools covered 5.5 acres in low spots of the main basin. The boundaries had become indistinct along several perimeter locations. New trenches and pits had been added at many locations in and around the main basin. Two trenches and four pits entered Basin A from the east near Source 36-16, an incendiary burial site. Four new trenches and three pits were observed near the eastern boundary of the main basin and may have been part of Source 36-17', a complex disposal/activity site having overlapping boundaries and a imprecise history. Slightly north of this, two long trenches and one pit projected into Basin A. Further north and slightly west one trench and four pits were observed inside the former boundary of Basin A. North of the dam yet within the main basin five trenches and six pits were observed.

As stated in the introduction to this source description several areas have been added to the investigation of 36-1'. The aerial photo from 1948 showed 3 trenches and a pit located just north of the neck of Basin A, yet outside the high water boundary. Slightly east of this area 3 new trenches and 3 or 4 new pits were observed in the 1975 aerial photograph. Between the Lime Settling Pits (36-4) and Basin A, a large area which appeared to have held liquids was observed. In addition to these areas the area between Basin A and the Liquid Storage Pool (36-11) has been possibly contaminated. An aerial photograph from 1958 shows that Pool 36-11 may have overflowed or been hydrologically connected with Basin A. The 1975 aerial photograph shows some trenching activity has occurred within this same area. A final extension to the boundaries of

Basin A consists of a small area on the west side of the basin directly south of the dam. In the 1975 photo two trenches have appeared.

#### Contaminants

A wide variety of organics including pesticides and agents were introduced to Basin A since 1943. Inorganic metals as well as inorganic non-metals are also present. The presence of ordnance at this site is expected in areas of former trenching. Surety material is expected within 36-1'.

The DAR states the following contaminants may be present:

Sulfur	Hydrochloric acid
Sulfur monochloride	Aluminum oxide
Sulfur tetrachloride	Phosphine oxide
Mustard	Chlorinated paraffins
Ethyl alcohol	White phosphorus
Caustic	Jellied gasoline residues
Sodium sulfate	Chlordane
Sodium chloride	Aldrin
Sodium hydroxide	Dieldrin
Sodium isopropoxymethyl	Endrin
Sodium carbonate	Sludge
Sodium fluoride	DIMP
Arsenious chloride	DCPD
Hydrofluoric acid	

#### Hydrogeology

Basin A is a topographic low, sloping to the northwest with inflow coming from the south via channels, pipeflow, and run off from topographic highs. The Basin is underlain by up to 40 ft of alluvium consisting of interbedded sands, silts, and clays (Figures A.1-2 and A-1-3). The alluvium is generally saturated and the water table is within 5 to 10 ft of the surface. The Denver Formation underlies the alluvium and exhibits a northwest trending channel in the bedrock surface. The Denver Formation consists of volcaniclastics, clay shale, lignite, sand channels, lenticular sands, and a small continuous sand unit. Two normal

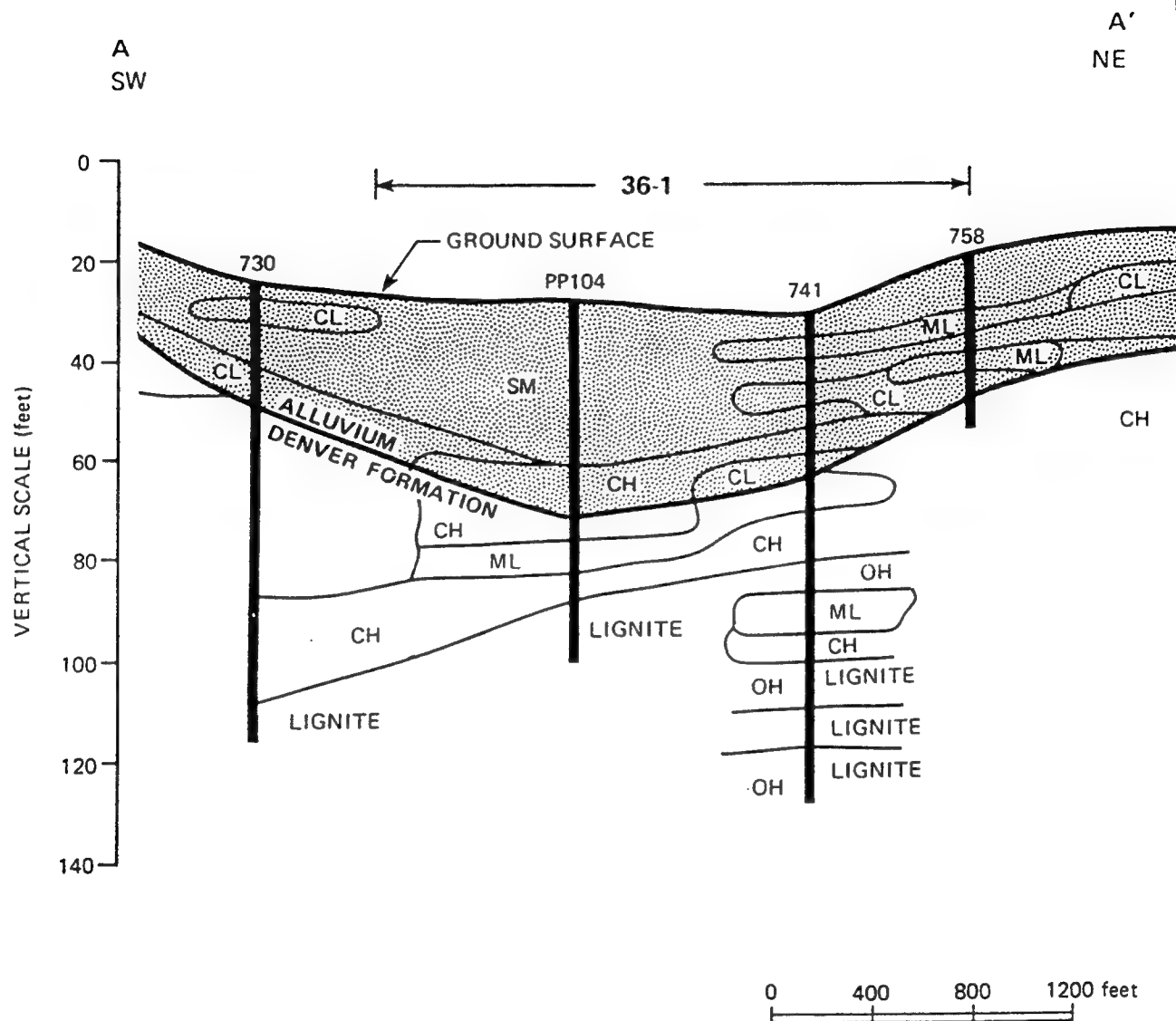


Figure A.1-2  
CROSS SECTION A-A' THROUGH  
CONTAMINATED SOURCE 36-1  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

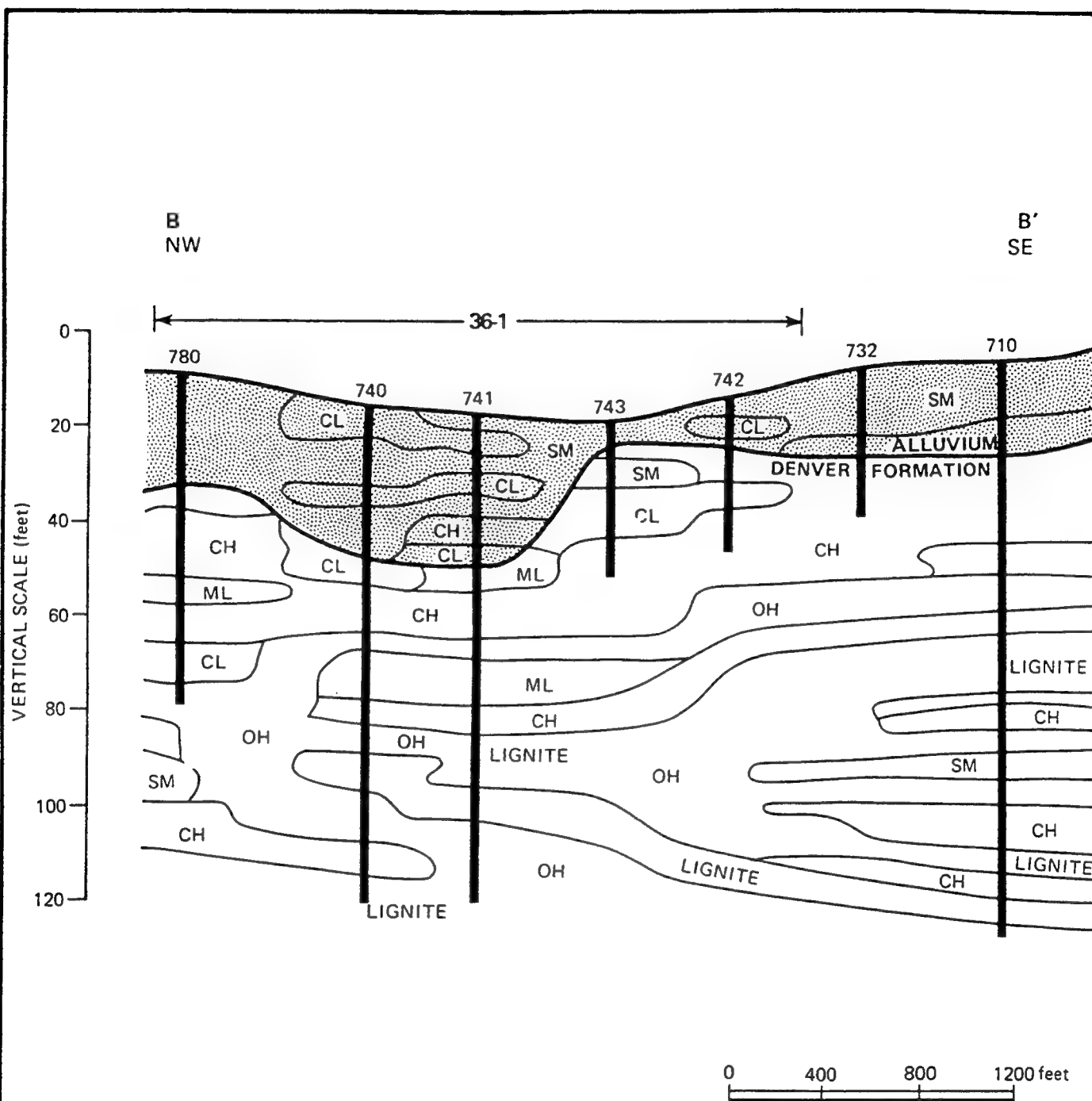


Figure A.1-3  
 CROSS SECTION B-B' THROUGH  
 CONTAMINATED SOURCE 36-1  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

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faults underlie the basin and intersect at the neck area (Figure 1.2-3). The alluvium is the principal aquifer for ground water flow through the basin although it is hydraulically linked to the Denver Formation in places. Flow direction is to the northwest in both the alluvium and Denver Formation. The recharge-discharge relationship between the alluvium and underlying bedrock changes throughout the basin. The faults in the center of the basin provide recharge to the alluvium through artesian pressures in the bedrock. Recharge from the bedrock to the alluvium may also take place along the southern edge of Basin A. Recharge of the bedrock from the alluvium may occur at the northeast and northern basin boundaries (DAR, 1984)\*. Volcaniclastics of low permeability may restrict flow between the alluvium and bedrock on the east side of Basin A.

#### Phase I Program

Based on an areal extent of 6,017,000 ft<sup>2</sup>, complex disposal history and Figure 3.3-1, a boring spacing of 150 ft was selected. This translates into 267 total Phase I and Phase II borings. The Phase I Program will construct 67 borings (25 percent of total borings) within 36-1'. The Phase I Program is as follows with borehole locations shown in Figure A.1-1. The symbol WT denotes the anticipated depth to the water table in this and all other source discussions of Appendix A.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
13	10.0 (WT)	39
27	5.0	54
27	1.0	27

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\* DAR - Privileged Litigation Information



Phase II Program

Contingent upon the results of the Phase I Program, 200 borings are proposed for the Phase II Program. The Phase II Program is proposed as follows with tentative borehole locations shown in Figure A.1-1, collecting a total of 330 samples.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
20	10.0 (WT)	60
90	5.0	180
90	1.0	90

## A. 2 SOURCE 36-3': INSECTICIDE PIT

This source is comprised of a series of pits and trenches believed to have been used for disposal of insecticides and pesticides. The location of this source is shown in Figure A.2-1 to the southeast of Basin A. Previous studies have compiled the following information for this source:

Estimated Areal Extent = 61,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

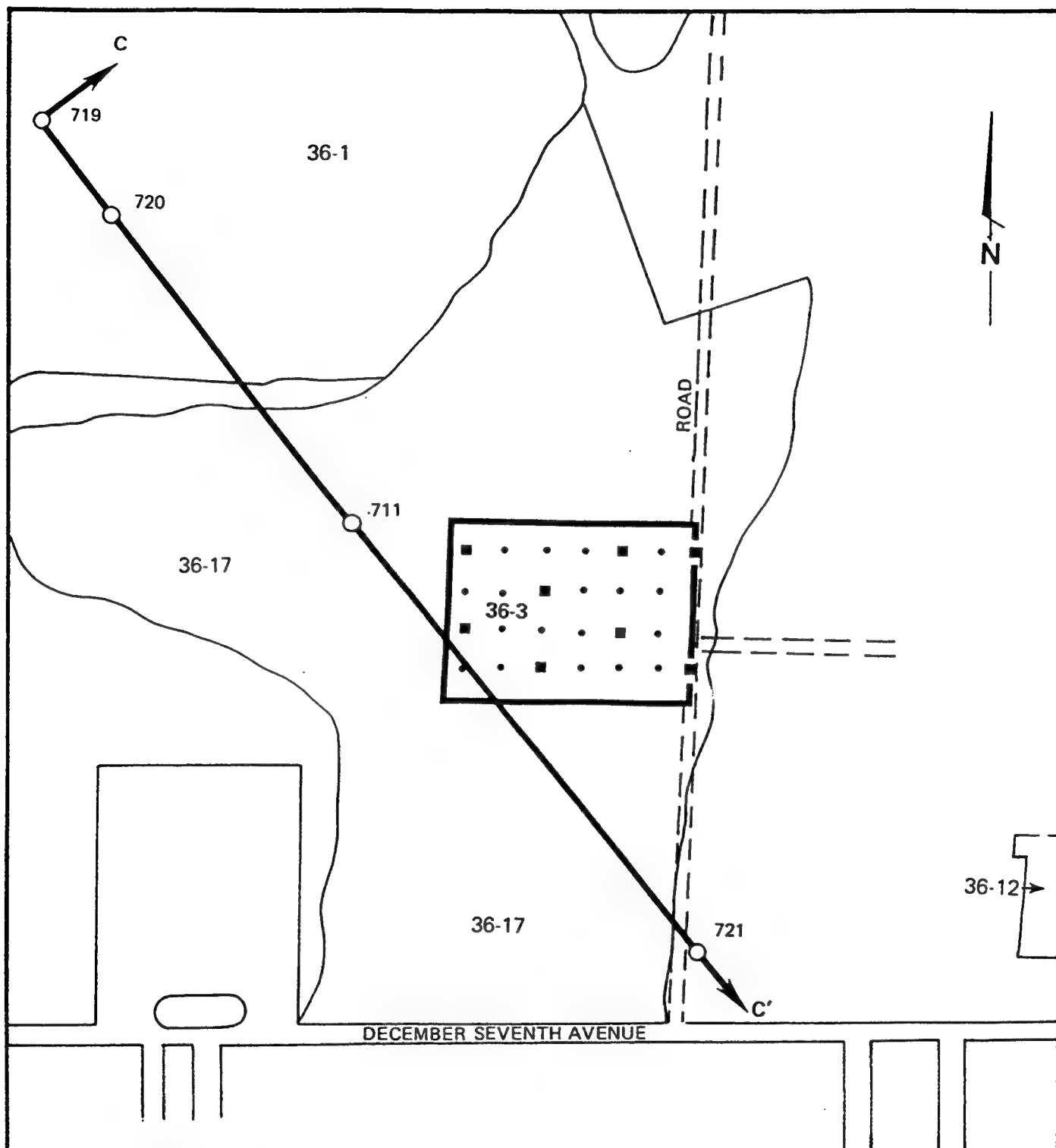
Estimated Volume = 23,000 yds<sup>3</sup> (RMACCPMT, 1984)

Revised Areal Extent = 211,000 ft<sup>2</sup>

Upon examination of aerial photographic interpretations and field reconnaissance this source areas has been expanded. Trenching activity at this locations apparently occurred over a much larger area than originally estimated. Although much of this trench disposal may not have resulted from pesticide activities, aerial photos show these trenching activities occurring at the same time as similar activities within the original Source 36-3' boundaries. Therefore, the areal extent has been revised to include other trenches and pits which may contain pesticides and insecticides.

### Disposal History

A study of aerial photographs has resulted in the identification of numerous pits and trenches at this site. In a 1953 photograph, a carefully prepared site exists with one long trench and one smaller adjacent trench. In a 1958 aerial photograph 4 to 8 trenches exist in the central region of the site. An aerial photograph from 1962 shows the existence of 8 to 12 additional trenches both north and south of the existing trenches. In addition, a single trench running from southeast to northwest appears north of the original site boundary. In summary, as of 1962 approximately 15 trenches exist at this site, all of which are confined to the area designated as the original Source 36-3'. A 1975 photograph shows 10 new trenches and 4 pits to the north of the original boundary with an additional 5 trenches and 4 pits within the original source area.



#### EXPLANATION

- Existing Boring Locations
- Phase I Boring Locations
- Phase II Boring Locations



Figure A. 2-1  
 BORING LOCATION MAP  
 CONTAMINANT SOURCE 36-3'  
 (Insecticide Pits)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

Prepared for:  
 U.S. Army Toxic and Hazardous  
 Materials Agency  
 Aberdeen Proving Ground, Maryland

Because this source is assumed to have been used for pesticide disposal it must be assumed that the new trenches and pits north of the original Source 36-3' boundary in Source 36-17' may also contain pesticides and insecticides. Therefore the area of this source has been altered to that pictured in Figure 1.2-2 and A.2-1 and, the volume estimated by Moloney (1982) as 744,400 yd<sup>3</sup> may be a more realistic estimate. Moloney (1982) estimated that 322,667 yds<sup>3</sup> was the actual volume of contaminated material within the pits and trenches, not considering the potentially uncontaminated soils between trenches and pits.

#### Contaminants

Because this disposal site was used for pesticide and insecticide disposal resulting from South Plants Area manufacturing, it can be assumed that this site may contain all such compounds manufactured at RMA. These compounds include numerous organochlorine pesticides and organophosphate pesticides. The DAR\* states the following compounds may be present.

Chlordane	Heptachlor	Parathion
Aldrin	Isodrin	Malathion
DCPD	DDE	Dithiane
Dieldrin	TDE	Thioxane
Endrin	DDT	

Neither surety material or UXO are expected at this site.

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\* DAR - Priviledged Litigation Information

### Hydrogeology

A cross section for the vicinity of Source 36-3' is shown as Figure A.2-2. The thickness of the alluvium is approximately 20 ft at this location. Assuming that trenches are 10 ft deep this leaves only 10 ft of alluvium from the base of trenches to bedrock. A silty sand lies beneath the source which in turn is underlain by alluvial clay. The Denver Formation beneath this source is comprised of interbedded clay, silt, and sand with high organic content below a depth of 60 ft.

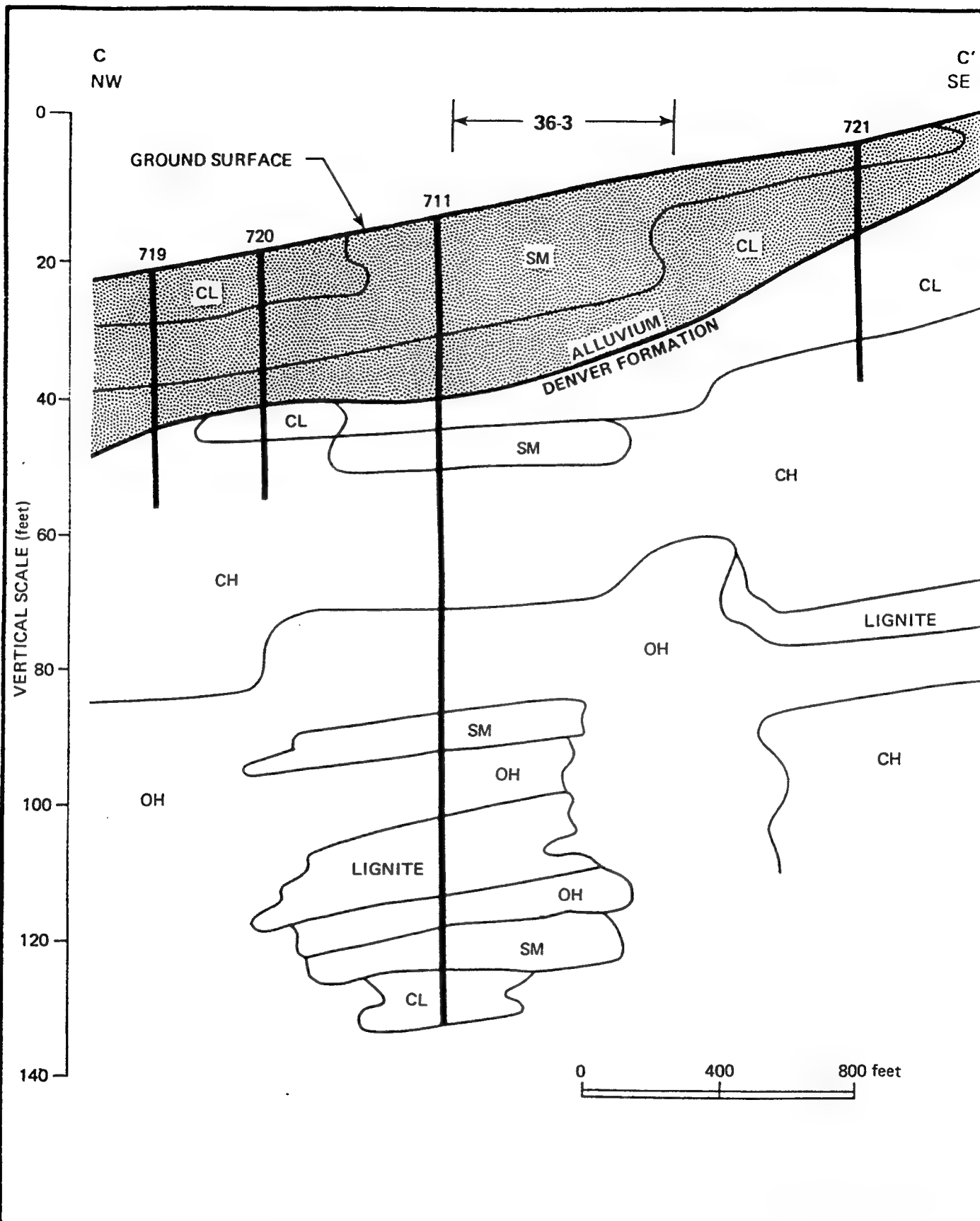
Surface drainage from this source is towards Basin A. In the 1975 aerial photograph a drainage ditch was visible from the trenches and pits draining towards Basin A. Therefore, this drainage ditch may have contained relatively high concentrations of pesticides.

### Phase I Program

Based upon an areal extent of 211,000 ft<sup>2</sup>, a complex disposal history, and Figure 3.3-1, the total number of borings for Source 36-3' was determined to be 26 (90 ft spacing). Eight of these borings are to be constructed during Phase I and 18 during Phase II. Borings were arranged in a regular grid pattern at 90 ft centers as shown in Figure A.2-1. Review of Phase I data prior to initiation of Phase II efforts will allow modification of proposed activities to eliminate data gaps if such gaps are identified.

The Phase I boring program for Source 36-3' is summarized below showing number of borings and samples collected. A total of 23 samples will be collected.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	15.0 (WT)	8
3	10.0	9
3	5.0	6



**Figure A. 2-2**  
**CROSS SECTION C-C' THROUGH**  
**CONTAMINATED SOURCE 36-3'**  
**(Insecticide Pits)**  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

Phase II Program

It has been estimated that Phase II of the boring program at source 36-3' will require 18 additional borings. Phase II boring locations will be situated using a grid system as shown in Figure A.2-1. However, the number of borings, sampling depths, and placement of borings may be altered upon assessment of Phase I data. The Phase II program is proposed as follows collecting a total of 48 samples.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	15.0 (WT)	8
8	10.0	24
8	5.0	16

### A.3 SOURCE 36-4: LIME SETTLING BASINS

This source is comprised of three large unlined basins each approximately one acre in size (Figure A.3-1). The basins were reported to be the initial receptors for all wastewaters from the South Plants Area. Waters were treated with lime to precipitate metals and reduce arsenic concentrations generated by Lewisite manufacture. The extent of these lime settling basins is as follows. The area of this source has not been changed or revised.

Estimated Areal Extent = 130,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

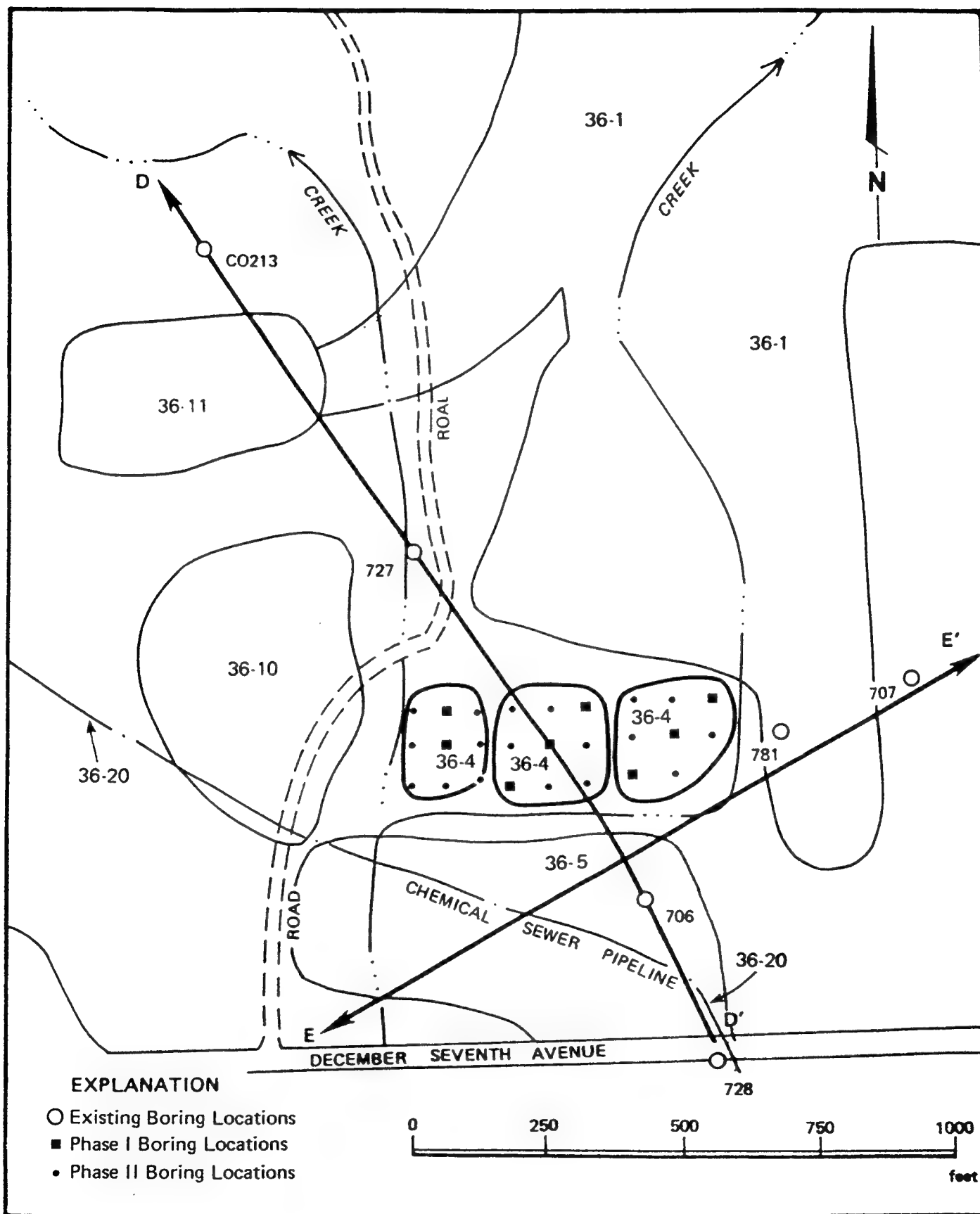
Estimated Volume = 48,000 yd<sup>3</sup> (RMACCPMT, 1984)

#### Disposal History

The lime settling basins were originally constructed to remove arsenic from South Plants waste waters by precipitation as  $\text{CaAsO}_4$ . However, waste liquids other than those from Lewisite manufacture were routed to the basins. It has been documented that all wastewaters originating from the South Plants Area were channelled through the lime settling basins to Basin A. A documented spill of 500 gallons of mercury catalyst occurred in the location of these basins. Additionally, over 150 drums of mustard were disposed of in these pits from 1959 to 1960.

Interpretation of aerial photographs showed that in 1948 three pits of approximately one acre each existed. By 1958 only the western lime basin was full of liquids. The center basin was dry with the exception of a small pool in the northwest corner. The eastern basin appeared full of sediments as liquid was confined to narrow channels on the edge of the basin. The 1962 aerial photo shows the western basin to be dry and filled in, with a northeast-oriented trench. To the west of the western basin several scars believed to be trenches were present. The central and eastern basins were full of liquids. In the 1975 aerial photograph all three basins had been filled and buried. The diagonal trench in the location of the western basin had been enlarged. Drainage ditches appeared to be draining this source area toward Basin B.





**Figure A. 3-1**  
**BORING LOCATION MAP**  
**CONTAMINANT SOURCE 36-4**  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

### Contaminants

As stated previously a mercury spill is thought to have occurred just south of the lime settling basins with mercury catalyst flowing into the basins. Several soil samples from the pits were obtained and were found to contain less than 0.4 ppm lead. Soils collected from the lime settling basins were found to contain elevated concentration of aldrin, chlordane, dieldrin, endrin, heptachlor, DDE, and DDT. For soil samples collected under the Office of the Surgeon General (OTSG) Program, concentrations of these pesticides exceeded 1,000 ppm and in some instances 10,000 ppm (Walden, 1976). In addition to pesticides, metals including zinc, copper, and arsenic were detected at relatively high concentrations. Neither surety material nor UXO are expected at this site.

### Hydrogeology

Figure A.3-2 and A.3-3 depict cross sections for the area of the lime settling basins. These basins are directly underlain by approximately 10 ft of silty sand and 10 additional ft of clay. The Denver Formation occurs at a depth of about 20 ft. In this location the Denver Formation is comprised of interbedded clays, silts, and sands with the top of the lower Denver Formation defined by a lignite horizon.

Surface water in the lime settling basins flows into Basin A. In the later stages of settling basin use, a drainage ditch connected these basins to Basin B.

### Phase I Program

Based upon an areal extent of 130,000 ft<sup>2</sup>, a complex disposal history, and Figure 3.3-1, a boring spacing of 70 ft was assigned to this source. Therefore, 26 total borings will be placed at this site with 8 for the Phase I investigation. The 8 borings will be constructed in locations shown in Figure A.3-1 in a grid pattern. The Phase I program will collect 18 samples.

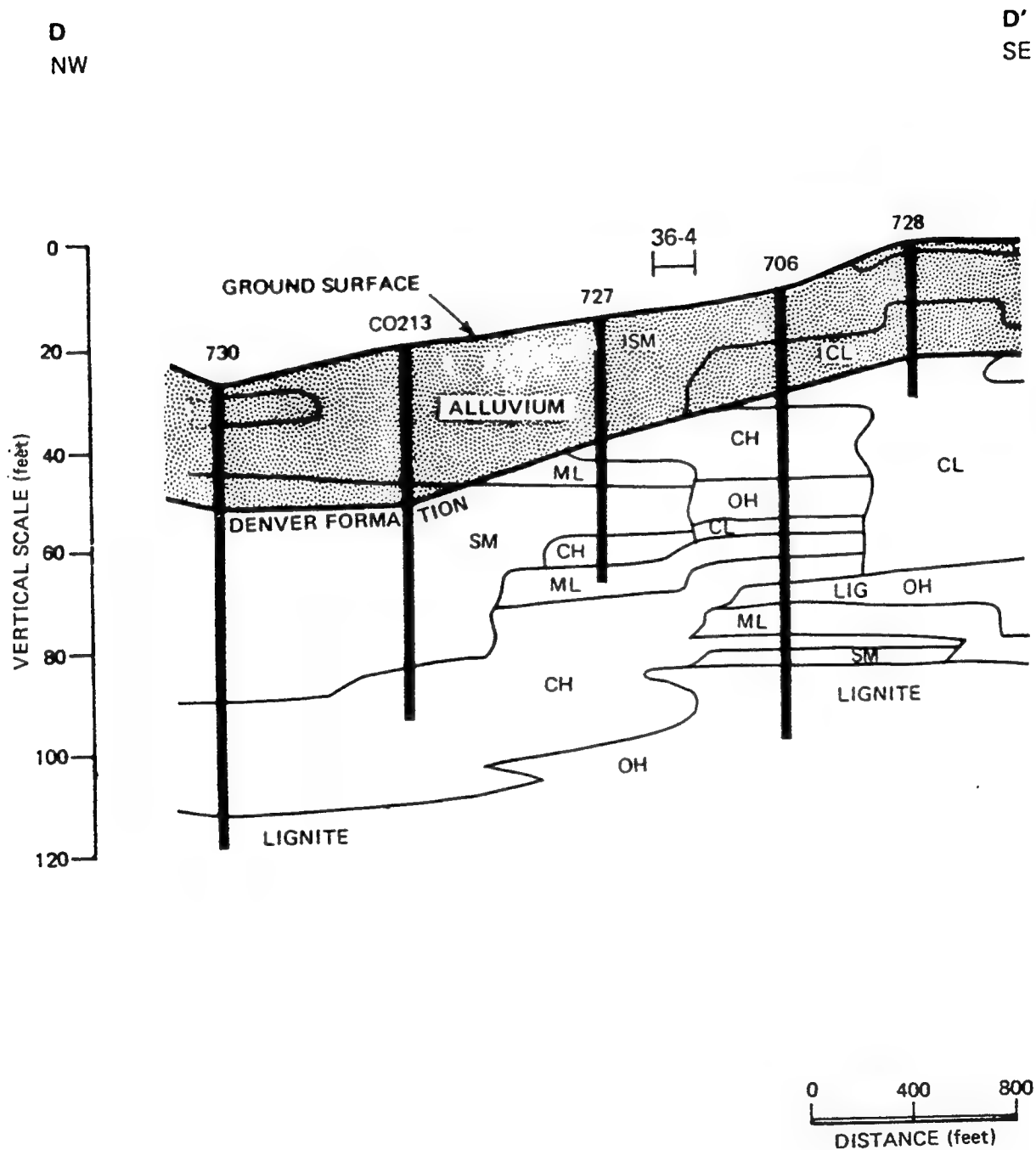
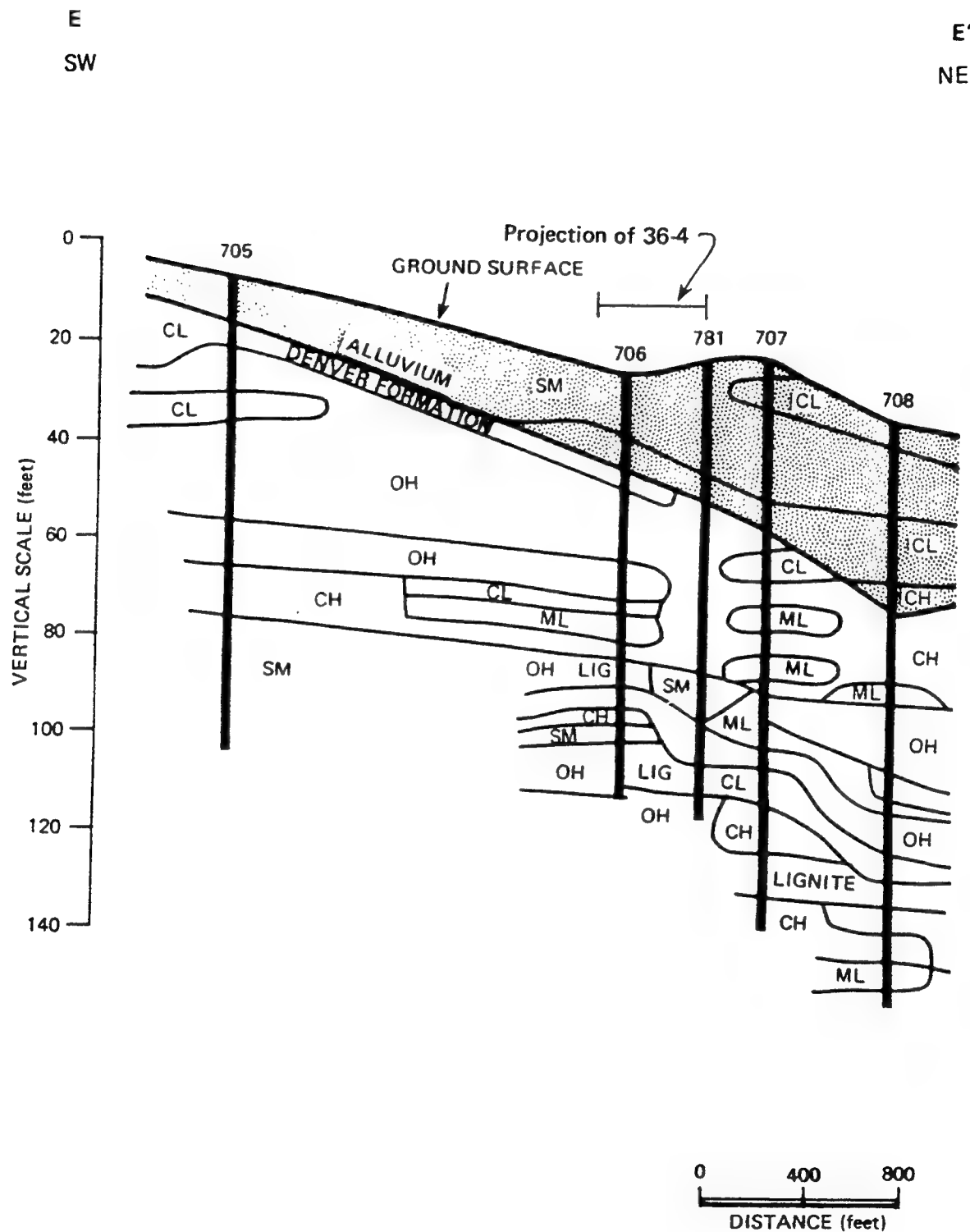


Figure A. 3-2  
CROSS SECTION D-D' THROUGH  
CONTAMINATED SOURCE 36-4  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

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Materials Agency  
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<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
6	5.0	12

Phase II Program

It is expected that during the Phase II investigation an additional 18 borings will be constructed. Placement of these additional borings will use a grid pattern as shown in Figure A.3-1. Although boring placement and the depth of investigation will be dependent upon results of the Phase I Program it is estimated that a total of 38 soil samples will be collected according to the following summary.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
16	5.0	32

#### A.4 SOURCE 36-5': MERCURY SPILL

This source, located to the south of the lime settling basins (Figure A.4-1), has resulted from a spill of about 500 gallons of mercury catalyst. Uncertainty exists as to the exact location of the spill and its extent. The original extent of contamination is as follows:

Estimated Areal Extent = 27,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 1,000 yd<sup>3</sup> (RMACCPMT, 1984)

Revised Areal Extent = 240,000 ft<sup>2</sup>

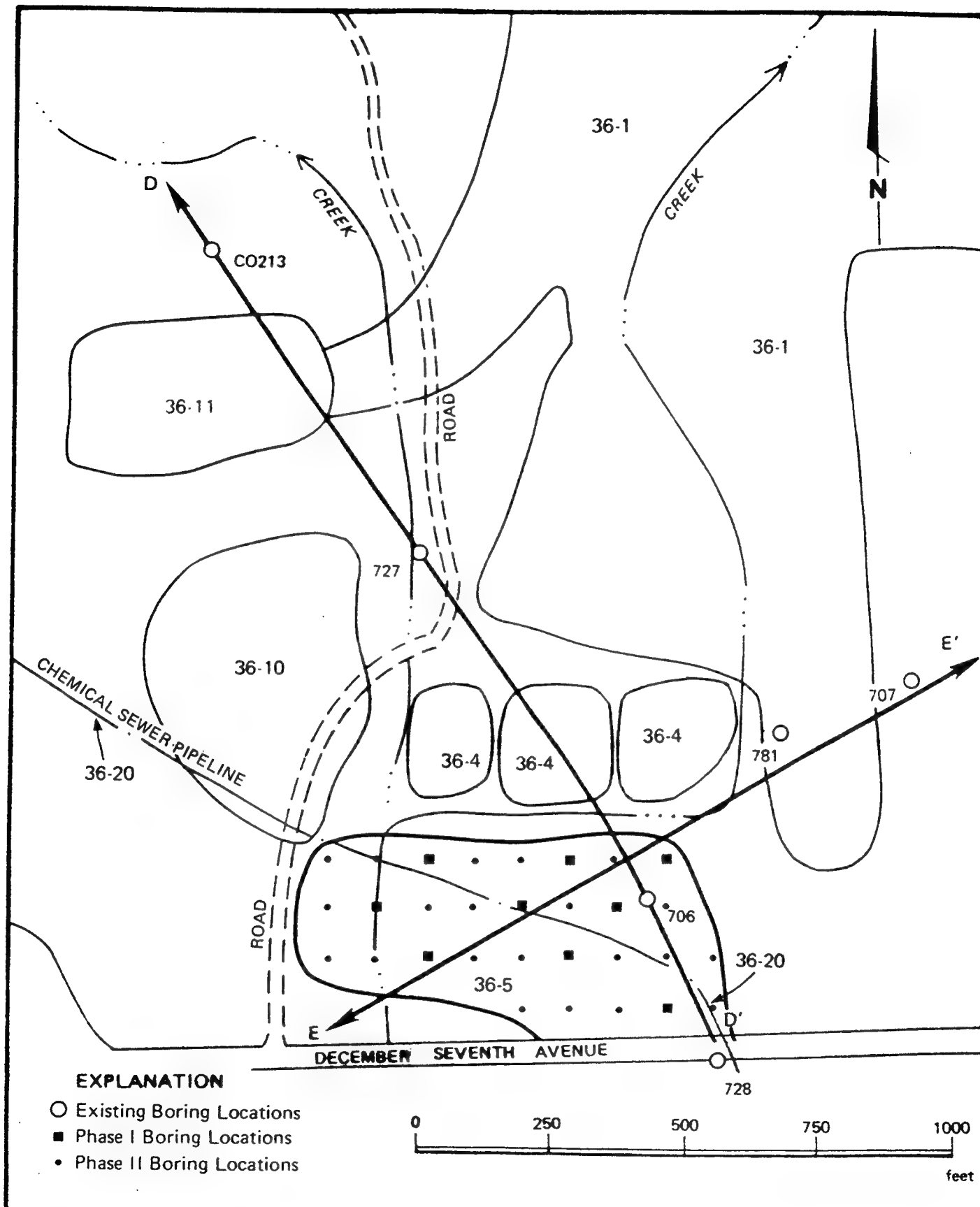
Interpretation of aerial photos and field reconnaissance have resulted in revising the areal extent of this source area. As the location of the mercury spill is uncertain and other disposal activity, including the presence of ponded water, trenches, and pits have been observed, the associated areal extent has been expanded to include areas of these activities.

#### Disposal History

Although a mercury catalyst spill was known to have occurred in this area in the late 1940's disturbances in this area have been observed on 1950, 1953, and 1958 aerial photographs. The disposal history for this location may be more complicated than originally conceived. In the 1950 photograph several disturbed patches with small irregular pools of liquid have been observed. One trench and four pits are evident. The 1958 photograph shows a one-acre area with five small pools of standing liquid. The 1958 photo shows one large diagonal trench present with four new interconnected pits. These disposal features may have had variety of purposes and a wide array of contaminants could be present.

#### Contaminants

The mercury catalyst spill is the only documented disposal activity which has occurred in this location. However, the existence of many pits and several trenches within this area and proximity to the lime settling basins increases the possibility of contamination by additional compounds. These contaminants may include heavy metals and the list of



**Figure A. 4-1**  
**BORING LOCATION MAP**  
 CONTAMINANT SOURCE 36-5'  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
 Aberdeen Proving Ground, Maryland

pesticides and pesticide by-products expected to be found in insecticide pits (Source 36-3'). Contaminants found in the Lime Settling Basins may also be expected at this location.

#### Hydrogeology

Surface water flow at this source is toward the lime settling basins and Basin A. The site is underlain by approximately 20 ft of alluvial material with approximately 10 ft of silty sand above approximately 10 ft of clay (Figure A.4-2 and Figure A.4-3). The Denver Formation beneath the site is comprised of interbedded silt, silty sands, clays, and organic rich clays, similar to the lithology beneath the lime settling basins.

The predominant direction of ground water flow is to the north with components toward the northwest. Ground water generally flows toward Basin A and out the Basin A neck area to the northwest.

#### Phase I Program

Based upon an areal extent of 240,000 ft<sup>2</sup> and a borehole spacing of 90 ft, the total number of Phase I and II borings was calculated to be 30. Of these 30 boreholes nine will be constructed during Phase I. Locations of Phase I borings can be seen in Figure A.4-1. A total of 20 samples will be collected in the following program.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
7	5.0	14



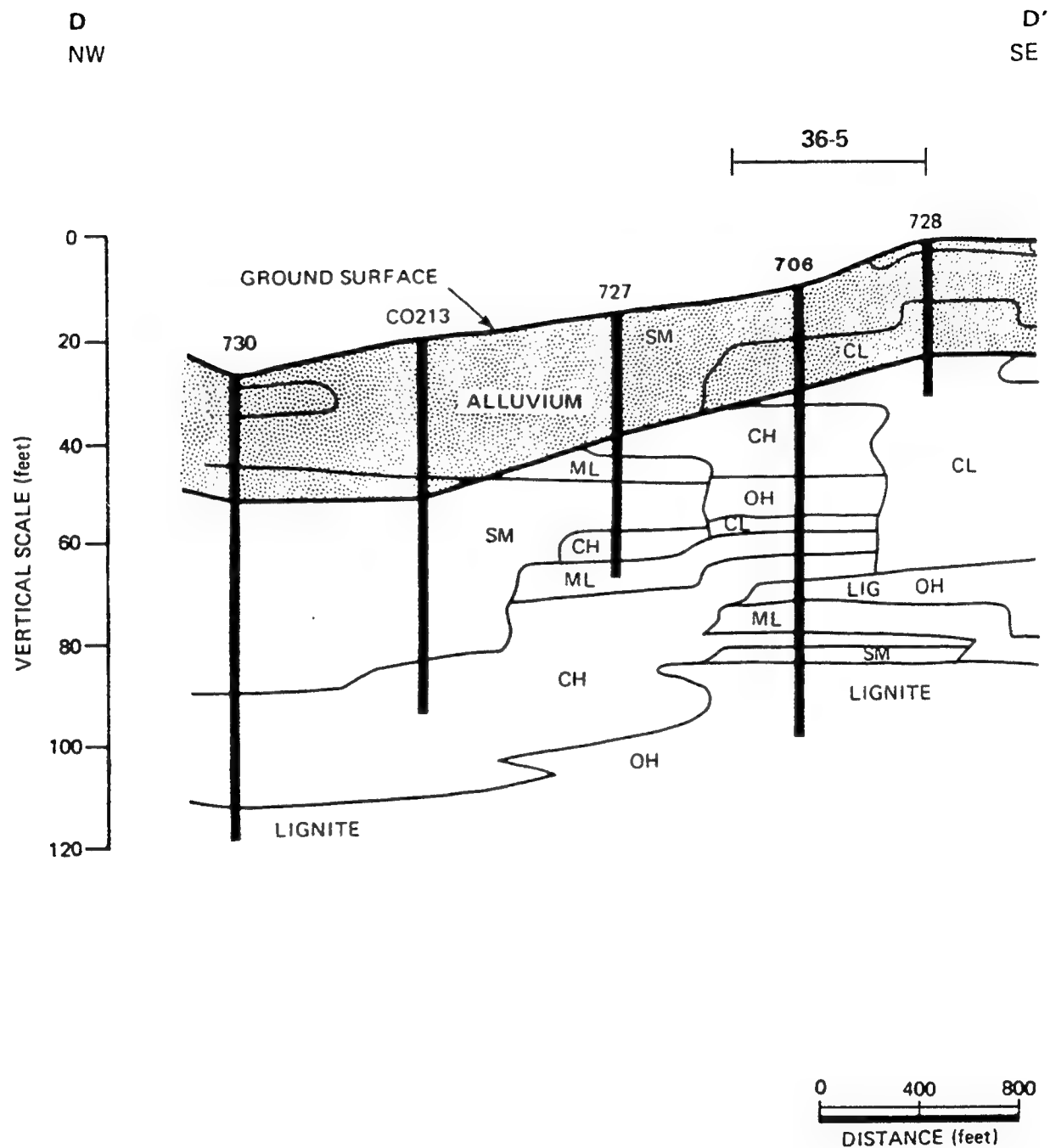


Figure A.4-2  
CROSS SECTION D-D' THROUGH  
CONTAMINATED SOURCE 36-5  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

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Aberdeen Proving Ground, Maryland

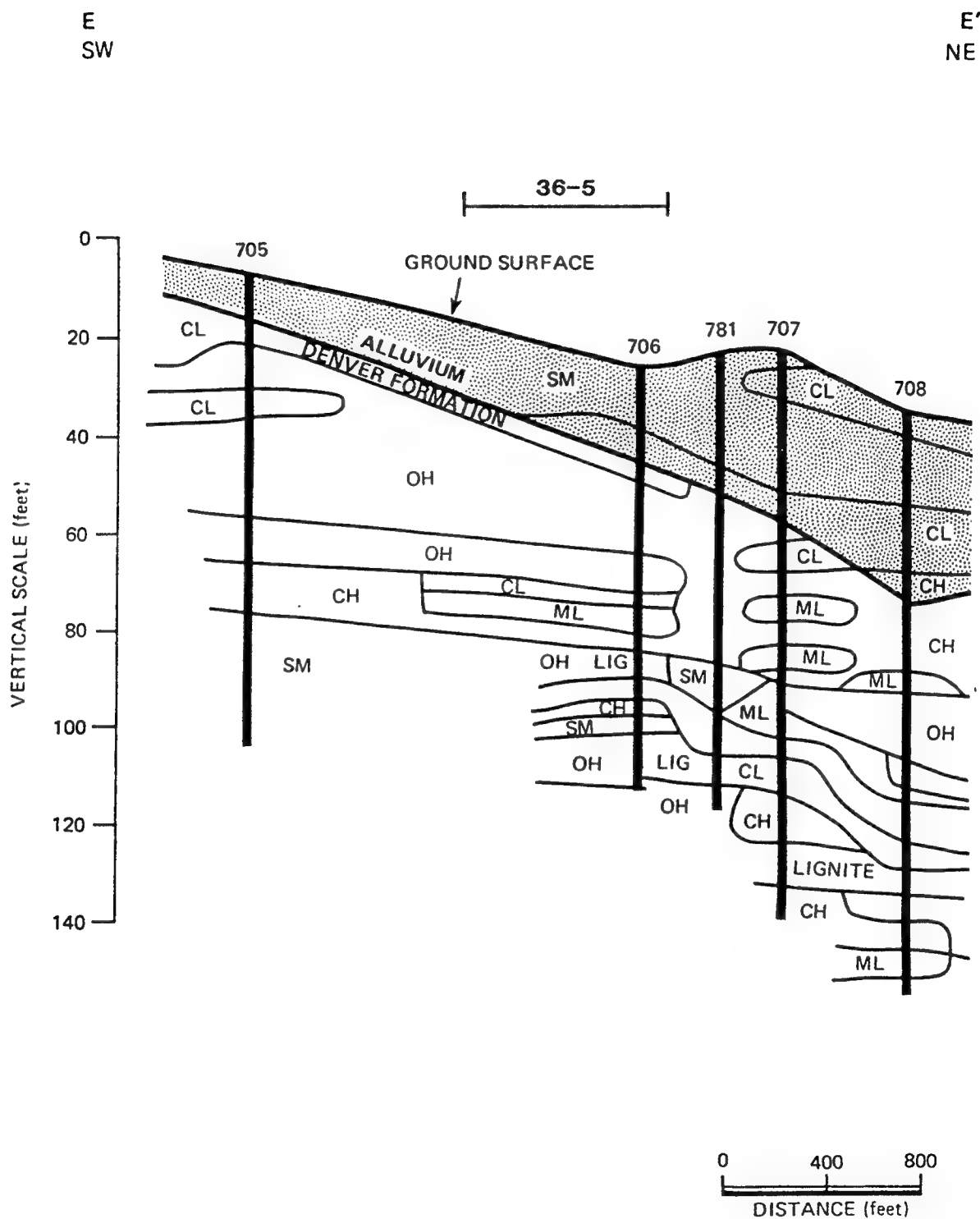


Figure A.4-3  
CROSS SECTION E-E' THROUGH  
CONTAMINATED SOURCE 36-5  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

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Phase II Program

It has been estimated that 21 additional borings will be constructed during Phase II. The number of borings and their borehole locations shown in Figure A.4-1, and depths are dependent upon results of Phase I. The Phase II Program will collect 44 samples and is summarized below.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
19	5.0	38

#### A.5 SOURCE 36-7': SOLID WASTE BURIAL/SANITARY PITS

This source is comprised of numerous pits and trenches (Figure A.5-1). These trenches were used for the destruction of munitions and burial of solid wastes. One area of this source was used as a sanitary landfill. The exact locations of some of these trenches is uncertain as the DAR contains two conflicting maps showing trench locations. The following information summarizes the original anticipated extent of contamination.

Estimated Areal Extent = 617,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 229,000 yd<sup>3</sup> (RMACCPMT, 1984)

Revised Areal Extent = 692,000 ft<sup>2</sup>

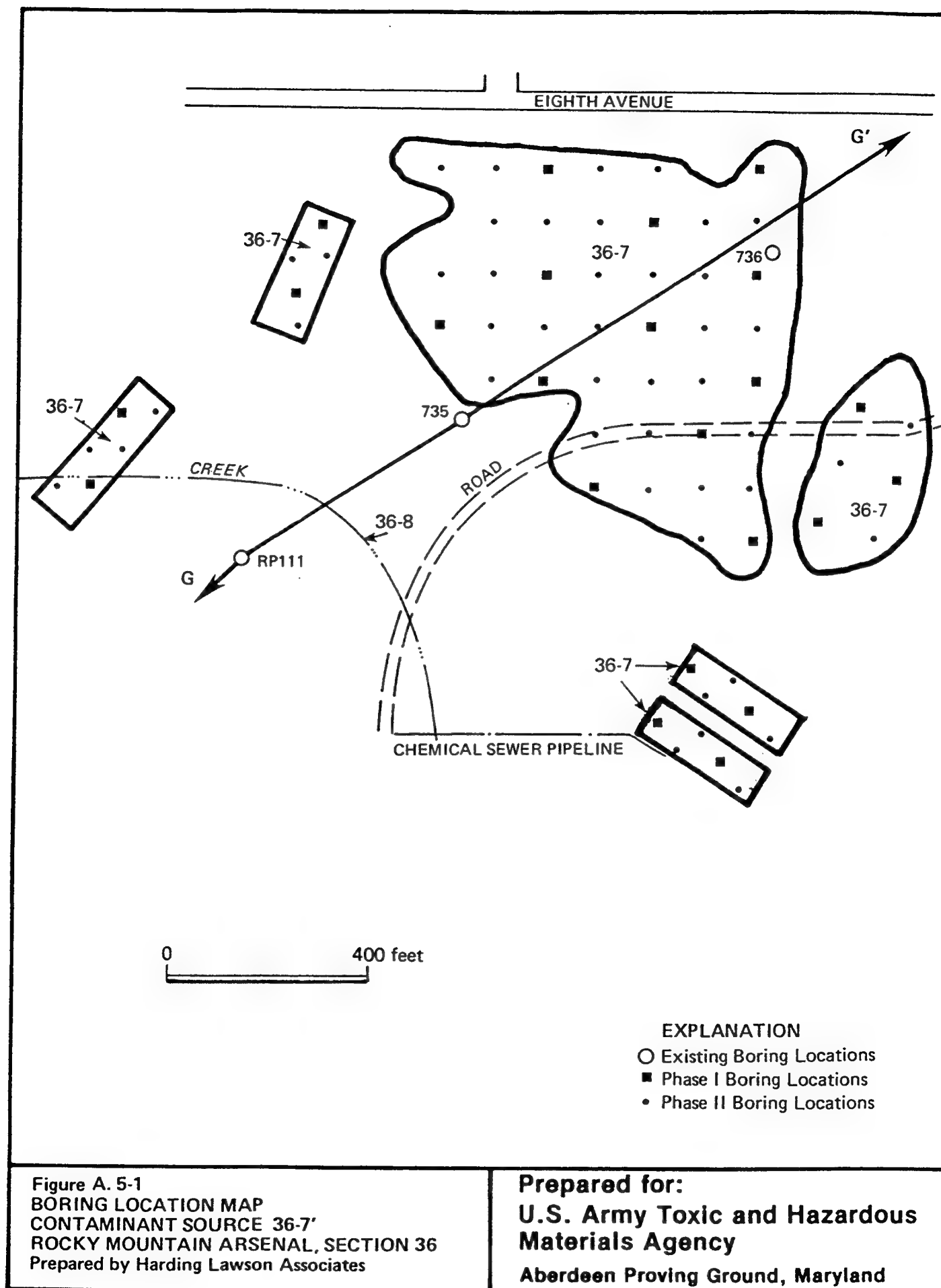
The areal extent of this site has been revised to include three additional rectangular-shaped areas. These areas were located from a map contained in the DAR (1984)\*. These areas are believed to contain trenches used for munitions disposal and burning as well as sanitary landfill disposal. These additional areas comprise of approximately 75,000 ft<sup>2</sup>.

#### Disposal History

This source area resulted from of a wide variety of disposal practices. The 1950 and 1953 aerial photographs show what appears to be remnants of a sanitary landfill which was known to exist in this area. Aerial photos from 1958 show evidence of pools and trenches in the northern portion of Source 36-7' adjacent to 8th Street. No activity was observed in the 1962 photograph, but by 1975 significant trenching and disposal activity had resumed within this area. Twelve trenches and 8 to 10 pits are evident. These trenches are located just west of the Shell Chemical Incinerator and the Technical Escort Furnace.

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\* DAR - Priviledged Litigation Information



### Contaminants

Some of these trenches were used for the destruction and disposal of incendiary bombs, white phosphorus (WP) grenades, mustard-filled (HD) projectiles, ID Set vials, M125 GB Bomblets, and material from the GB Plant. Several pits are known to contain demilitarized residue and residue from neutralization of off-specification GB. Soil samples have been collected from within the Source 36-7' boundary area. These samples were analyzed under the OTSG Program for a wide variety of metals and pesticides. Relatively low concentrations of aldrin, endrin, and dieldrin were detected. These soils appear to be most heavily contaminated by metals such as copper and zinc. However, the small number of samples collected may not be representative of the entire source area, as specific trenches or pits may contain specific contaminants. For example, a hypothetical pesticide disposal pit may not have been sampled during this work effort, resulting in detected levels of pesticides lower than may actually exist.

### Hydrogeology

A geologic cross section is presented in Figure A.5-2 and shows that this site is located on the edge of a bedrock (Denver Formation) outcrop. Ground water flow at this point is generally to the west. Recharge towards the southwest from this portion of the Denver Formation to the alluvium is anticipated. Surface water drains from this source to the Basin A neck and on to Basins C through E.

### Phase I Program

Based upon an areal extent of 692,000 ft<sup>2</sup> for Source 36-7', an extremely complex disposal history and Figure 3.3-1 a borehole spacing of 110 ft was selected for the central area and 70 ft for the outlying rectangular

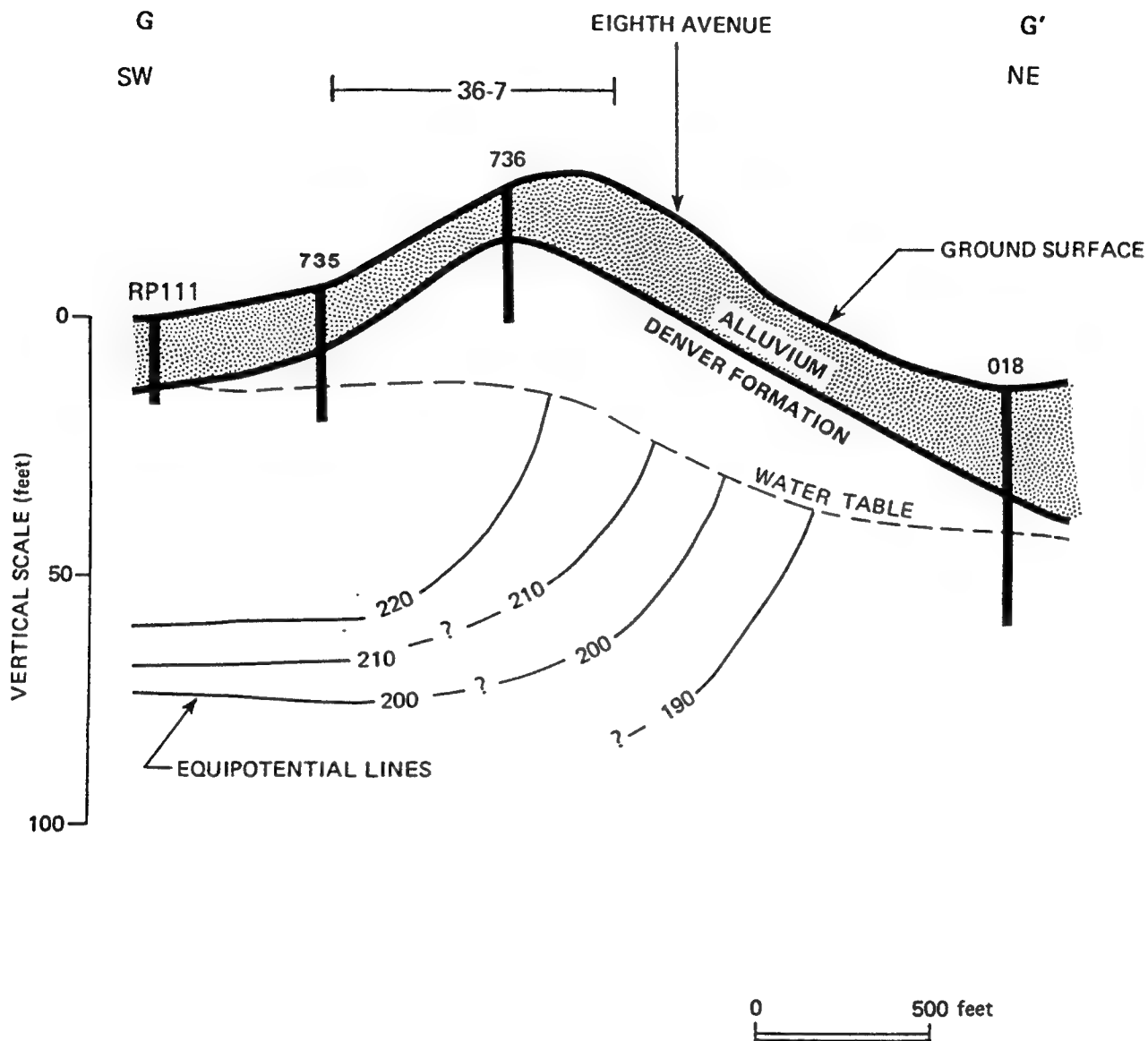


Figure A.5-2  
 CROSS SECTION G-G' THROUGH  
 CONTAMINATED SOURCE 36-7  
 (Sanitary & Shell Chemical Co. Disposal Sites)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

Prepared for:  
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shaped areas. This translates to a total of 69 borings of which 23 are to be constructed during Phase I. A total of 70 samples will be collected in the following program.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
5	20.0 (WT)	25
9	10.0	27
9	5.0	18

Tentative locations of these borings are shown in Figure A.5-1 and were selected using a uniform grid pattern. However, it is expected that with so many trenches and pits present, the borings will be sited to penetrate disposal trenches/pits. The location of these borings will be finalized during the initial site reconnaissance and geophysical program.

#### Phase II Program

The number of Phase II borings is anticipated to be 46. The results of Phase I sampling will govern the number, locations and depths of all Phase II borings. If Phase I results suggest the depth of contamination is deeper than anticipated, more borings will extend to the water table.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
5	20.0 (WT)	25
21	10.0	63
20	5.0	40

Background information suggests that there has been no significant pesticide disposal in this location and that contamination is mostly by heavy metals. Such contamination is not easily mobilized in the local alkaline soils and relatively neutral ground waters of this area. Concentrations of copper and zinc typically drop off quickly with distance from a metal source under such conditions.



#### A.6 SOURCE 36-8: CHEMICAL DRAINAGE DITCH

This source is an open chemical drainage ditch which is comprised of two parts. The northern section of this source is a manmade ditch extending from the north end of Basin A to the western edge of Section 36 (Figure A.6-1). The southern portion is a natural drainage which runs from the South Plants Area north around the liquid storage pool (36-11) and exits Section 36 on its western edge (Figure A.6-2). The following values have been estimated for the extent of contamination.

Estimated Areal Extent = 22,200 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 8,000 yd<sup>3</sup> (RMACCPMT, 1984)

#### Disposal History

The above estimates are probably realistic for the ditches themselves but the area surrounding these ditches may also contain contaminants.

Contaminants from these unlined ditches have most likely penetrated the ditch bottoms and are being leached through the unsaturated zone towards the water table. Because these ditches were unlined a much larger volume of contaminated soils may exist. The southern drainage ditch appears to have been flooded some time during the period from 1962 to 1975. Aerial photographs from 1975 show a high water mark from Basin A that encompasses the upper portion of this southern ditch. Therefore, soils adjacent to this ditch which have been considered uncontaminated by the DAR\* may in fact contain detectable levels of contaminants. Prior to 1962 no evidence of the southern or northern drainage ditches have been noted on aerial photographs.

#### Contaminants

The southern portion of this source drains the South Plants Area and therefore the potential contaminants may include heavy metals such as copper, lead, zinc, and mercury as well as a complete list of pesticides manufactured at RMA including aldrin, chlordane, dieldrin, and endrin.

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\* DAR - Privileged Litigation Information

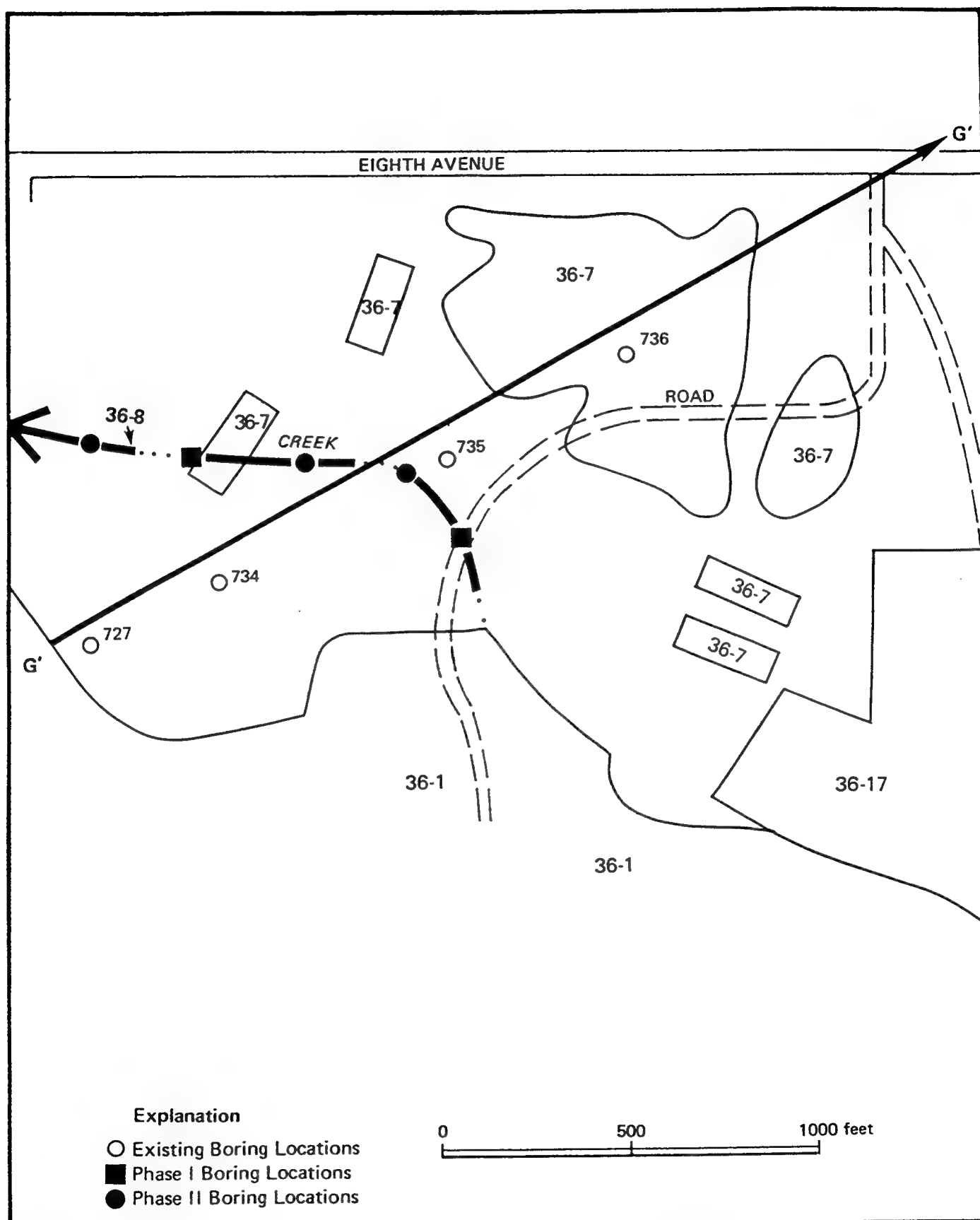


Figure A. 6-1  
 BORING LOCATION MAP  
 CONTAMINANT SOURCE 36-8 NORTH  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

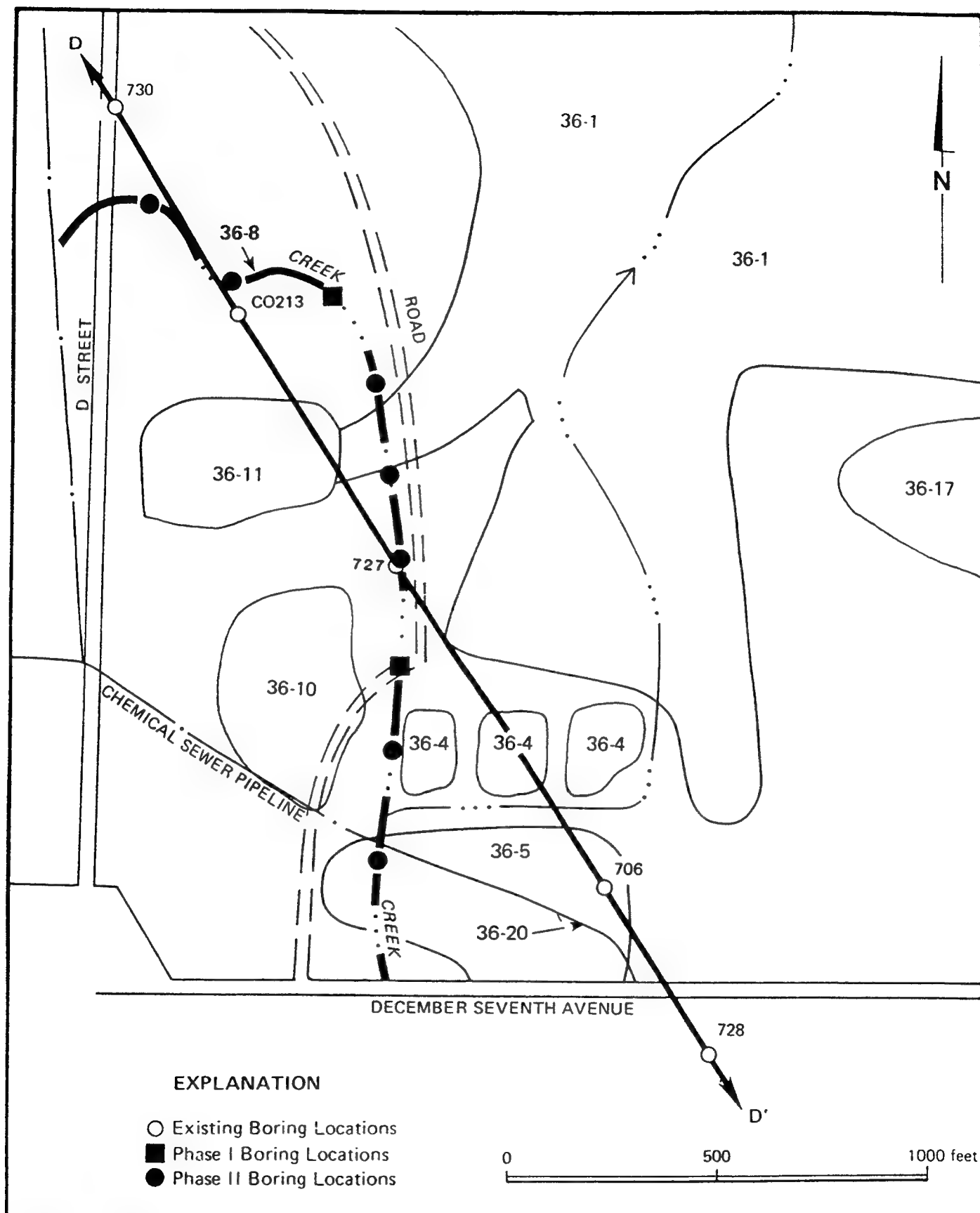


Figure A. 6-2  
BORING LOCATION MAP  
CONTAMINANT SOURCE 36-8 SOUTH  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

The northern portion of this contaminant source appears to be draining burning and munitions disposal trenches. Therefore, the primary contaminants in the ditch would most likely be heavy metals. As the Shell incinerator is in close proximity to this ditch system, the potential for pesticide presence can not be ruled out. Neither section of this source is expected to contain surety material or UXO.

#### Hydrogeology

The northern drainage ditch is situated in alluvium along the bedrock channel which extends from the Basin A neck into Section 35. The thickness of the alluvium may be up to 30 ft. The southern portion of this source is underlain by 10 to 20 ft of alluvium. The bottom of this ditch is believed to be in contact with the water table in the alluvium and, when full, will act as a recharge source.

The geologic cross sections for Source 36-8 are shown in Figures A.6-3 and A.6-4 for the northern and southern portions, respectively. The northern ditch is directly underlain by silty sand 10 ft in thickness which in turn is underlain by clay and Denver Formation. The southern ditch is underlain by a similar silty sand approximately 30 ft in thickness.

#### Phase I Program

Based on an areal extent of 22,200 ft<sup>2</sup> and a complex disposal history, a total of 14 borings are planned evenly distributed along the ditches. The Phase I Program calls for the construction of 4 borings, two in each of the source ditches. It is anticipated that borings of 10 ft will encounter the water tables at their respective locations. Boring locations are shown in Figure A.6-1 and A.6-2. A total of 10 samples will be collected during Phase I with a program as follows.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Sample</u>
2	10.0 (WT)	6
2	5.0	4

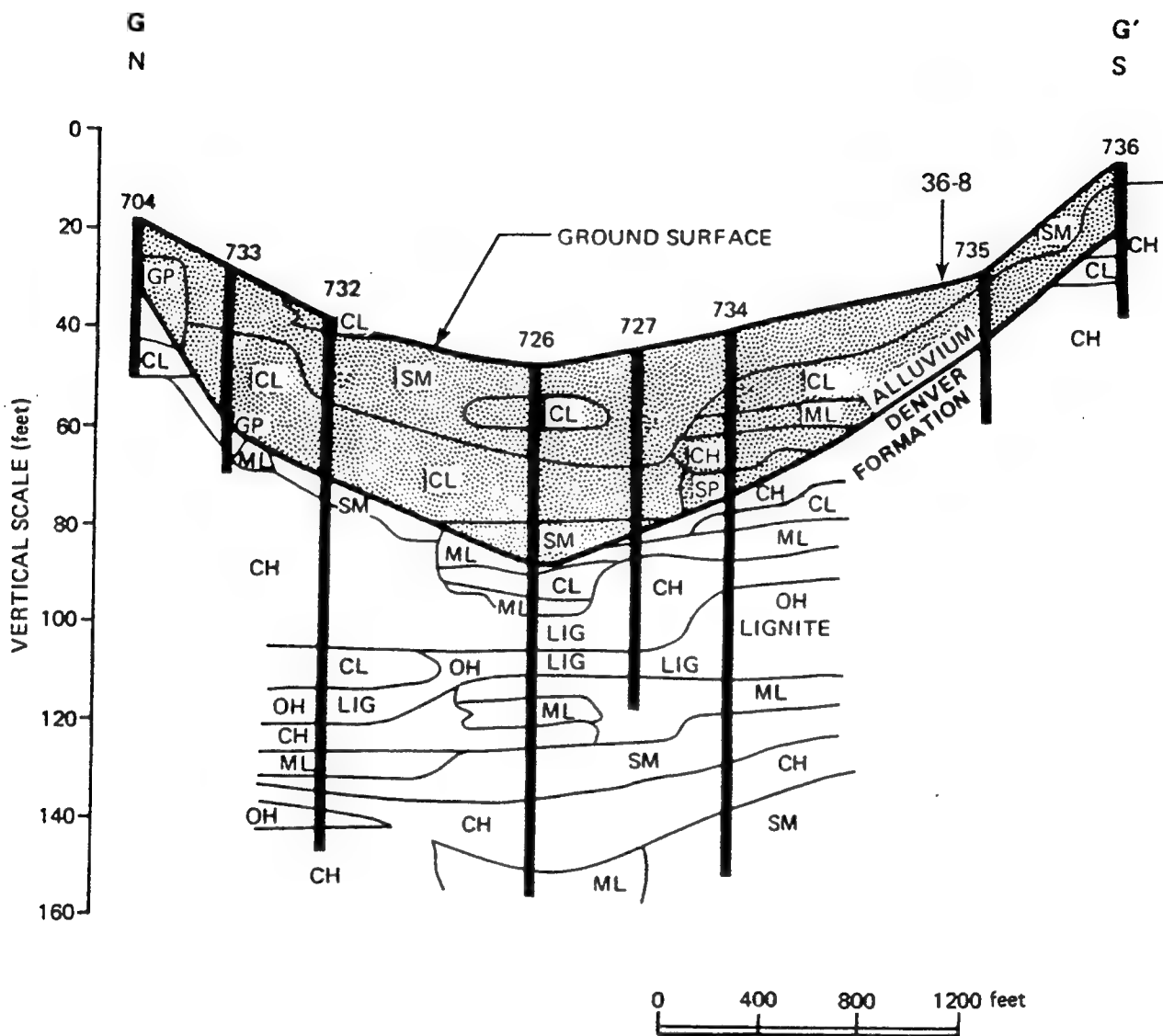


Figure A. 6-3  
CROSS SECTION G-G' THROUGH  
CONTAMINATED SOURCE 36-8 NORTH  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

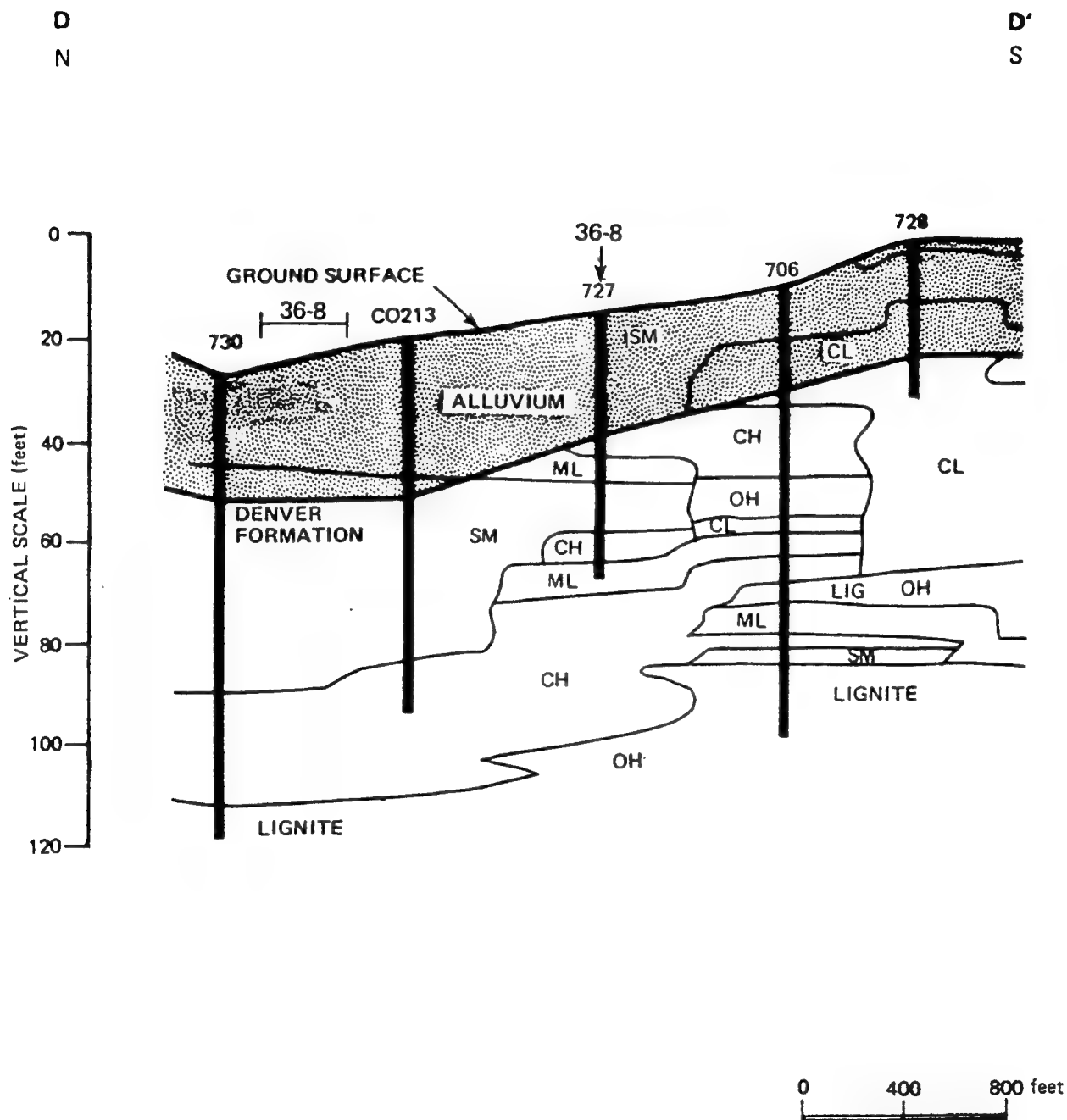


Figure A. 6-4  
 CROSS SECTION D-D' THROUGH  
 CONTAMINATED SOURCE 36-8 SOUTH  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
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Phase II Program

The second phase of the investigation will be based upon evaluation of Phase I data. A total of 10 additional borings are expected to be completed during the Phase II Program with 22 samples being collected.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
8	5.0	16

#### A.7 SOURCE 36-10: PIT

This source is a large pit located to the west of the lime settling basins (Figure A.7-1). The source is approximately four acres in size and is believed to have been used for burial of solid wastes. The estimated extent of contamination is summarized below:

Estimated Areal Extent = 173,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 64,000 yd<sup>3</sup> (RMACCPMT, 1984)

#### Disposal History

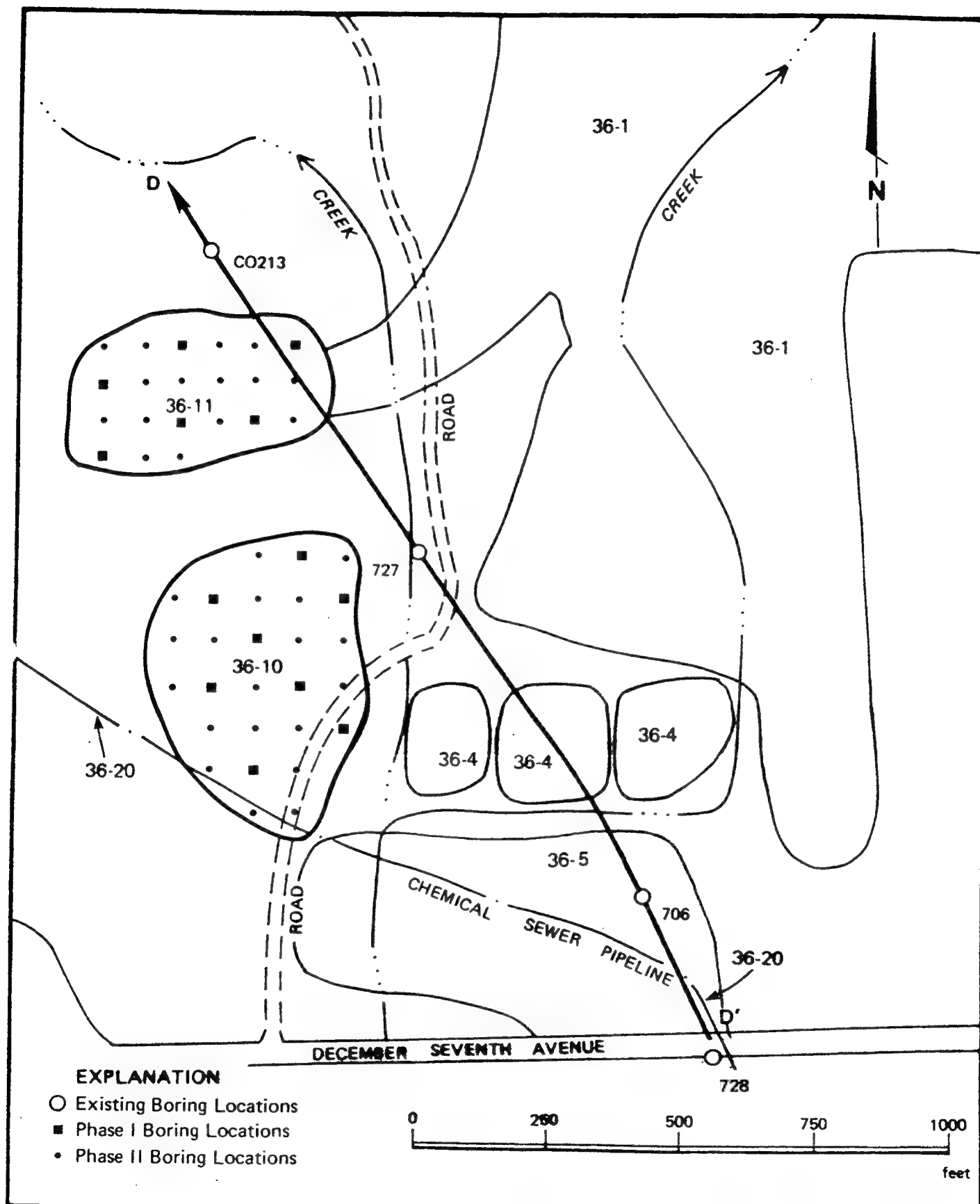
Aerial photographs prior to 1958 show no activity in this area. The 1962 photograph shows a single large pit located to the northwest of the lime settling basins with six or seven long narrow objects on the eastern edge of the pit. It was not possible to discern the types of objects present but these objects may verify that the pit was used for solid waste burial. The 1975 aerial photograph shows that this area was relatively inactive. Due to the uncertain disposal history of this site it must be assumed that waste liquids from the South Plants Area as well as solid materials may have been disposed of at this location.

#### Contaminants

Due to the proximity of this pit to the South Plants Area and due to the fact that the high water mark for Basin A extends into the pit in the 1962 aerial photograph, it is anticipated that a wide variety of contaminants may exist in this location. Under the OTSG Program a single boring was constructed and 3 soils collected from depths down to 12 ft. Chemical analyses of these soils yielded relatively high concentrations of copper (5 to 18 ppm) and zinc (28 to 53 ppm) with significantly lower concentrations of arsenic (110 to 180 ppb) and mercury (30 to 90 ppb). There was no detectable aldrin, chlordane, dieldrin, endrin, or DDT present in these soils at detection limits utilized.

Ground waters have been collected from Wells 44 and 48, which are within the source area, but no chemical data are currently available. However,





**Figure A. 7-1**  
**BORING LOCATION MAP**  
 CONTAMINANT SOURCE 36-10 and 36-11  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
 Aberdeen Proving Ground, Maryland

ground water data from Well 45, which is 200 ft downgradient (north) of the source, is available.

This well is screened in the Denver Formation from 53 to 57 ft below land surface. Chemical data from this well do not show significant contamination with the exception of 0.9 ppm DIMP in 1978, although detection limits are relatively high. Fluoride was present at approximately 1.4 ppm and chloride at 232 ppm. Pesticides (aldrin, dieldrin, endrin, and isodrin) were below the detection limit of 0.3 ppm, and sulfoxide, sulfone, oxathiane and dithiane were not detected at or above 10 ppm, which is considered a high detection limit for these compounds.

Discrepancies may exist concerning the volume of contaminated material at this location. The volume of the pit was estimated at 32,267 yds<sup>3</sup> (Moloney, 1982) but the DAR\* cites a volume of 64,000 yd<sup>3</sup>.

#### Hydrogeology

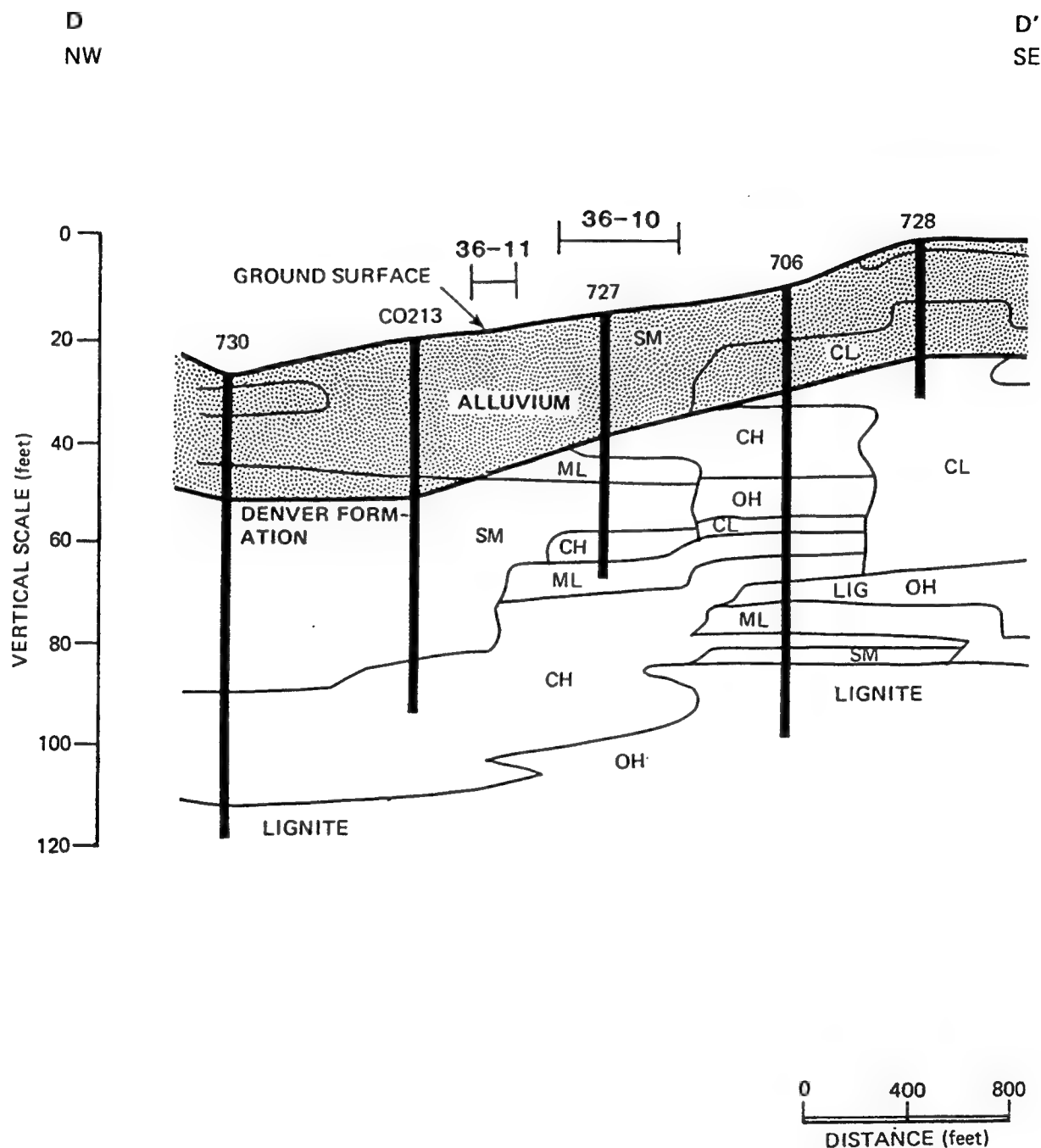
Source 36-10 is located on a low hill upon which the South Plants Area is constructed. Surface waters flow northward towards Basin A. Upon examination of surface topography and water table elevations it is expected that ground water exists at a depth of approximately 10 ft. The predominant direction of ground water flow is to the northwest through the Basin A neck. A geologic cross section for this source is contained in Figure A.7-2. The site is underlain by about 25 ft of alluvial sandy silt. Beneath this depth the Denver Formation consists of interbedded clays, silts, and organic rich clays.

#### Phase I Program

From the estimated areal extent of 173,000 ft<sup>2</sup> and Figure 3.3-1, a borehole spacing of 80 ft was selected which translates into 27 total borings. Eight of these borings will be constructed during Phase I at

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\* DAR - Priviledged Litigation Information



**Figure A.7-2**  
**CROSS SECTION D-D' THROUGH**  
**CONTAMINATED SOURCE 36-10 and 36-11**  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

locations shown in Figure A.7-1. These locations were derived from use of a uniform grid pattern. A total of 18 Phase I soil samples will be collected according to the following program.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
6	5.0	12

Phase II Program

Based upon the results of Phase I data the number, locations, and depths of Phase II borings will be finalized. It has been estimated that there will be an additional 19 borings constructed during Phase II with 40 soil samples being collected.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
17	5.0	34

#### A.8 SOURCE 36-11: LIQUID STORAGE POOL

This source is located northwest of the lime settling basins and covers an area of approximately 3 acres. This source originally consisted of two unlined basins used for storage of liquids. The origin of the stored liquids is unknown although it can be assumed that waste waters from the South Plants Area are the predominant liquids. Estimates concerning the extent of contamination for this source are as follows for the southern pool only (Figure A.7-1):

Estimated Areal Extent = 102,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 38,000 yd<sup>3</sup> (RMACCPMT, 1984)

It is assumed that these estimates do not include both north and south liquid storage pools, as the areal extent of the southern pool is approximately 100,000 ft<sup>2</sup> and the southern pool is the only pool identified on Figure 2.1.1.1 of the DAR\*. Therefore, the northern pool has been included in this program as a separate site (36-22').

#### Disposal History

This liquid storage pool was first observed in the 1953 aerial photograph. The pool was approximately 1.5 acres in size. In the 1958 aerial photo, the pool increased in size with a high water area of about 3.5 acres and was connected with Basin A. Therefore, it is assumed that waters from this pool had mixed with those of Basin A.

In the 1962 photograph the pool appeared drier than in the 1958 photo. The same coloration as observed in Basin A, existed in this pool suggesting that similar waters occupied Basin A.

The aerial photo from 1975 shows that the pool was dry and had been disturbed. This disturbance appeared to be two pits in the center of the pool and a semi-circular trench and pit in the eastern edge of the former pool. This area is currently dry.

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\* DAR - Priviledged Litigation Information

### Contaminants

Because liquids contained in this pool were of the same origin as Basin A liquids and were in direct contact with Basin A during a portion of their history, it can be assumed that the contaminants present may be the same. This waste water was generally of high total dissolved solids with calcium, sodium, chloride, and sulfate being the primary contributors. A single boring was constructed within the boundary of the pool and two soil samples were analyzed for organic and inorganic contaminants. These soils showed elevated concentrations of copper (10 ppm) and zinc (30 - 40 ppm) similar to soils from Source 36-10. Mercury concentrations were measured from 70 to 130 ppb and arsenic concentrations ranged from 120 to 230 ppb. Measurable concentrations of dieldrin and DDT were also found.

A single ground water monitoring well is located within the source area and ground waters show measureable concentrations of arsenic (68 ppb) and DIMP (16.1 ppb). A wide array of pesticides/insecticides were not detected at detection limits used. However, this well is completed in the Denver Formation at a depth of 48 to 52 ft and does not yield ground water quality data representative of the alluvial ground water beneath the source area. No surety material or UXO are anticipated at this source.

### Hydrogeology

A geologic cross section of Source 36-11 is presented as Figure A.7-2. The alluvium is approximately 20 to 25 ft thick in this area. The alluvium consists of silty sand to the Denver Formation.

The pool is situated in a topographically low area and little or no surface drainage appears to flow into or out of this area. Ground water flow may have both westerly and northerly components in this area as a result of localized ground water mounding. Flow is probably into the Basin A area and towards the Basin A neck region.

Phase I Program

Based on an areal extent of 102,000 ft<sup>2</sup>, a complex disposal history, and Figure 3.3-1, a borehole spacing of 70 ft was selected. The total number of borings was determined to be 21. Of the total borings 6 are to be constructed during Phase I. These borings will be situated in a grid pattern with a total of 14 soil samples collected. A summary of the program is given below.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
4	5.0	8

Phase II Program

Locations of Phase II borings as well as depth and sampling intervals will strongly depend upon analysis of Phase I data. It is anticipated that 15 additional Phase II borings will be constructed at the liquid pool to depths of 5 to 10 ft to determine the areal extent of contamination. The 15 Phase II boring locations are arranged in a grid pattern and take into account the locations of Phase I borings. Phase II is proposed to collect 32 soil samples as follows.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
2	10.0 (WT)	6
13	5.0	26

#### A.9 SOURCE 36-12: PITS/TRENCHES

This source is comprised of a series of three pits and trenches in the southeast corner of Section 36 (Figure A.9-1). The three sites are each approximately one acre in size and were used for disposal of solid wastes including pesticides and insecticides. The extent of contamination at this site has been estimated as follows:

Estimated Areal Extent = 120,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 44,000 yd<sup>3</sup> (RMACCPMT, 1984)

#### Disposal History

No activity was observed in aerial photographs prior to 1953. In 1953, three separate groups of trenches were observed. Each of these groups contained four or five long trenches. It has been established that these trenches were utilized for disposal of off-specification or unused pesticides and insecticides or other solids resulting from manufacturing processes in the South Plants Area. Aerial photos from 1950 show no disturbances and no new disturbances are observed beyond 1958. Therefore, the maximum period of usage of these trenches was approximately 8 years.

#### Contaminants

Because this site was primarily used for the disposal of pesticides and insecticides from the South Plants Area, suspected contaminants include a list of organochlorine and organophosphate pesticides.

Final products manufactured in the South Plants Area include the following compounds:

Chlordane	Heptachlor	Parathion
Aldrin	Isodrin	Malathion
DCPD	DDE	Dithiane
Dieldrin	TDE	Thioxane
Endrin	DDT	



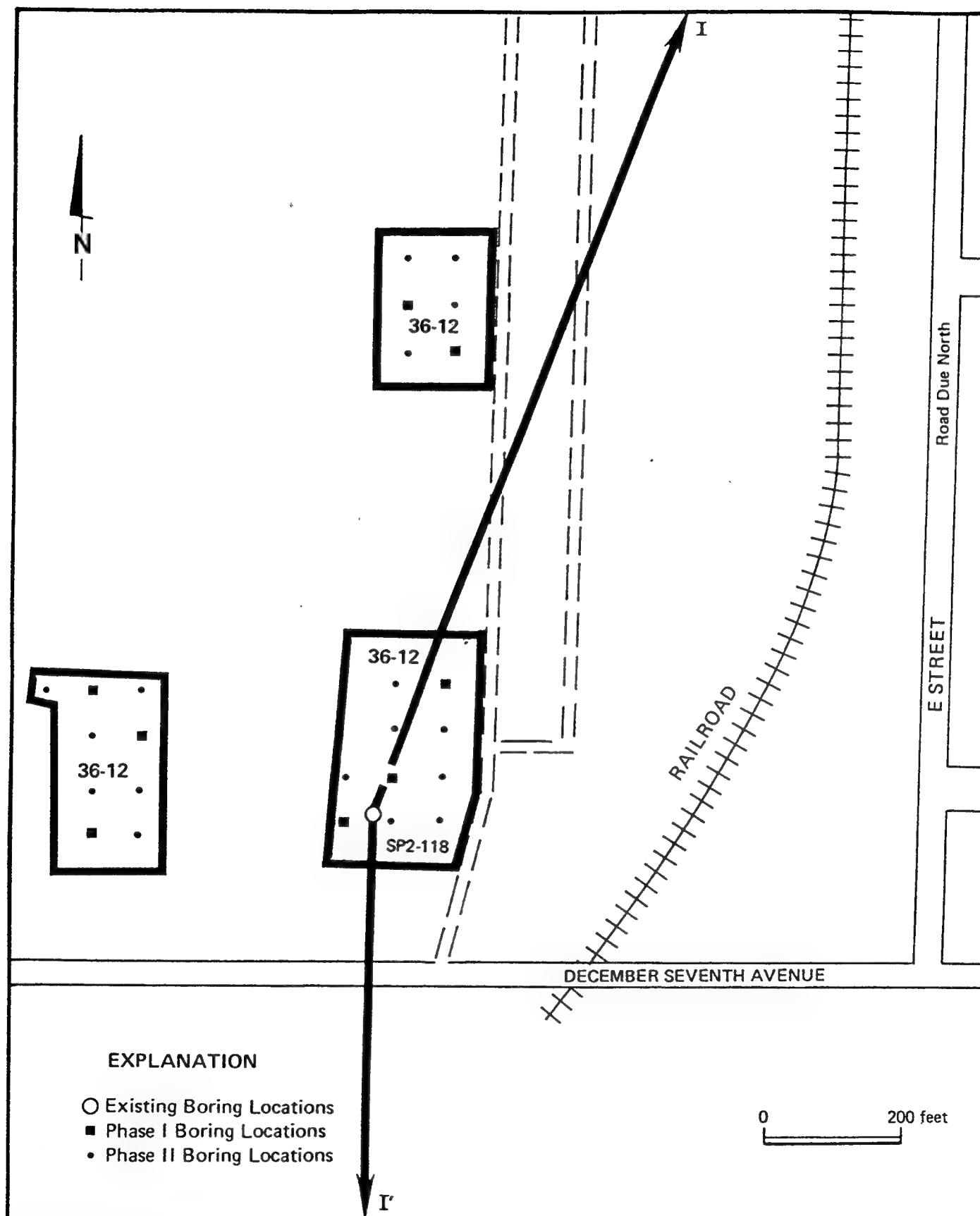


Figure A. 9-1  
BORING LOCATION MAP  
CONTAMINANT SOURCE 36-12  
(Pits or Trenches probably used by Shell Chemical Co.)  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

In addition to these compounds it is expected that numerous degradation products and manufacturing by-products will appear in site 36-12 soils. No surety materials or UXO is expected at this site.

#### Hydrogeology

A geologic cross section of strata underlying this source is shown in Figure A.9-2. The site is situated on a topographic ridge southeast of Basin A. The ridge forms the divide between drainage to First Creek and Basin A. The alluvium is about 30 ft thick beneath this site and is dry. The ground water table is in the Denver Formation.

No ground water monitoring wells exist in close proximity to this site, and, therefore, no accurate data are available concerning ground water flow directions in this area. Ground water flow may be either to the east (First Creek) or west (Basin A).

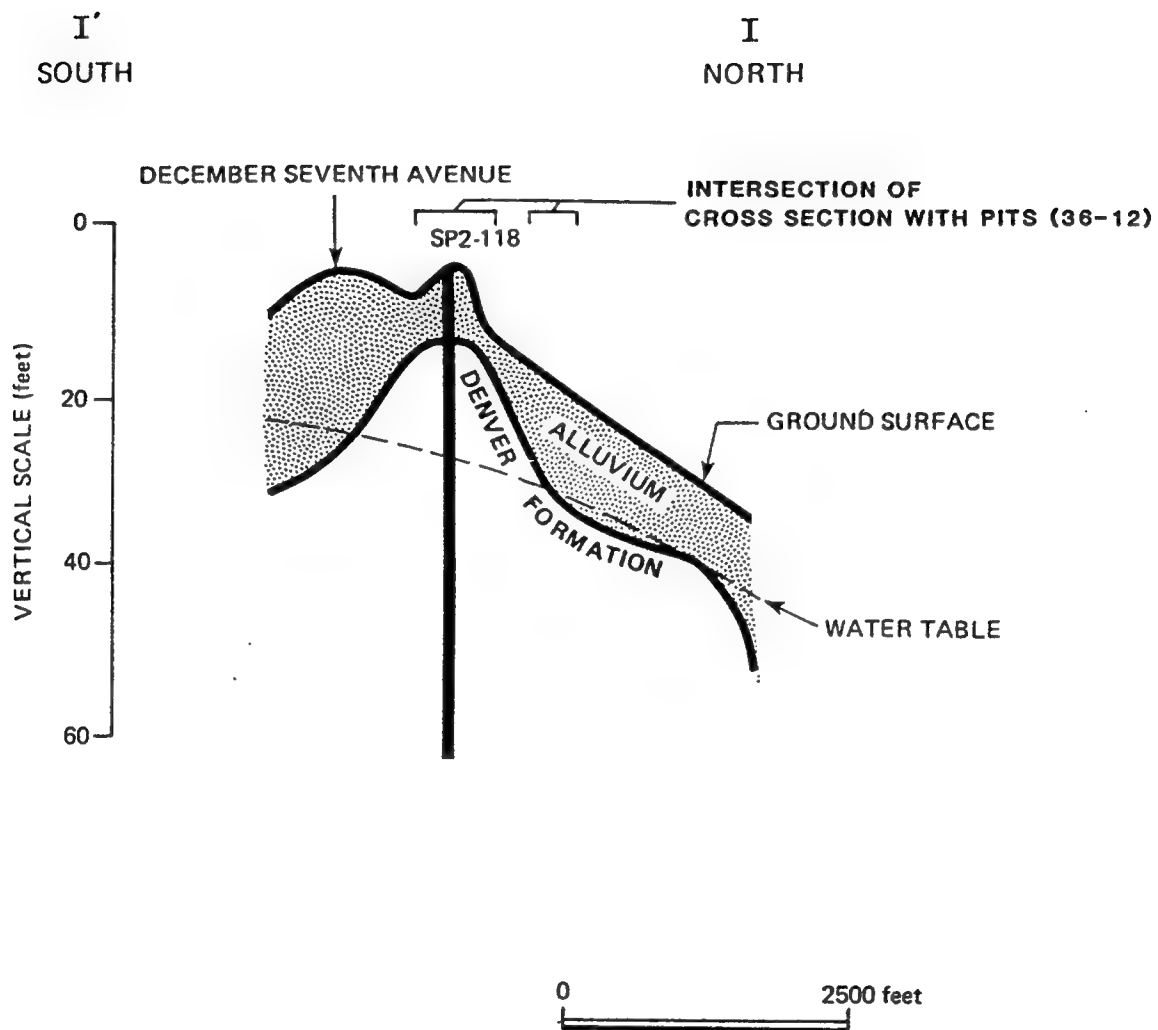
#### Phase I Program

Based on an areal extent of 120,000 ft<sup>2</sup>, complex disposal, and Figure 3.3-1 selection of a borehole spacing of 70 ft resulted in a total of 25 borings. Of these 25 total borings 8 will be constructed during Phase I. Three borings will be assigned to each of two groups of trenches and two borings to a third group of trenches. A total of 25 soil samples will be collected according to the following strategy.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
3	20.0 (WT)	15
5	5.0	10

#### Phase II Program

The Phase II Program may be altered upon evaluation of Phase I data. Alterations may include increasing or decreasing the number of borings, borehole depth, and borehole locations. However, at this time it is



Reference: May, 1982, Plate 13

**Figure A.9-2**  
**CROSS SECTION I-I' THROUGH**  
**CONTAMINATED SOURCE 36-12**  
 (Pits or Trenches probably used by Shell Chemical Co.)  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
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**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

estimated that Phase II borings will be situated in a uniform grid pattern as shown in Figure A.9-1. An estimated total of 17 boreholes will be constructed during the Phase II Program. A total of 43 soil samples will be collected according to the following program.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
3	20.0 (WT)	15
14	5.0	28

#### A.10 SOURCE 36-15: BURNING SITE

This source is located within the high water mark of Basin A (Figure A.10-1) and was used for the burning of obsolete and unwanted munitions including incendiary devices, bursters, bomblets, and a variety of other munitions. Data compiled for this source are:

Estimated Areas Extent = 128,000 ft<sup>2</sup>

Estimated Vertical Extent = 10 ft

Estimated Volume = 7,000 yd<sup>3</sup> (RMACCPMT, 1984)

The volume of contaminated soil may be underestimated, as another document (Moloney, 1982) estimates the volume of soil as 96,800 yd<sup>3</sup> and the actual volume in trenches as 32,267 yd<sup>3</sup>. As these values are significantly different, the evaluation of this site will be performed with this discrepancy in mind.

#### Disposal History

This site was used for disposal of munitions. The method of disposal for such munitions typically consisted of dumping into open trenches. The munitions were covered with fuel oil, the trenches ignited and allowed to burn. When the capacity of the trenches was reached, they were usually backfilled. Prior to 1958 there did not appear to be any activity in this area. In the 1962 aerial photograph four to eight long trenches are visible. As disposal in trenches is the probable reason for contamination, it must be assumed that other compounds may have been disposed of in this location.

#### Contaminants

This source was used for the burning and disposal of a variety of munitions. These munitions probably included incendiary bombs, M34 WP grenades, HD-filled projectiles, M125 bomblets, and burster tubes. Trenches would, therefore, contain residues from these burning processes as well as remains of these munitions. Close proximity to Source 36-1' activities and the fact that this source is within the high water mark of Basin A would suggest there is a high probability of contamination by a wide range of organic compounds. UXO is expected at this site.

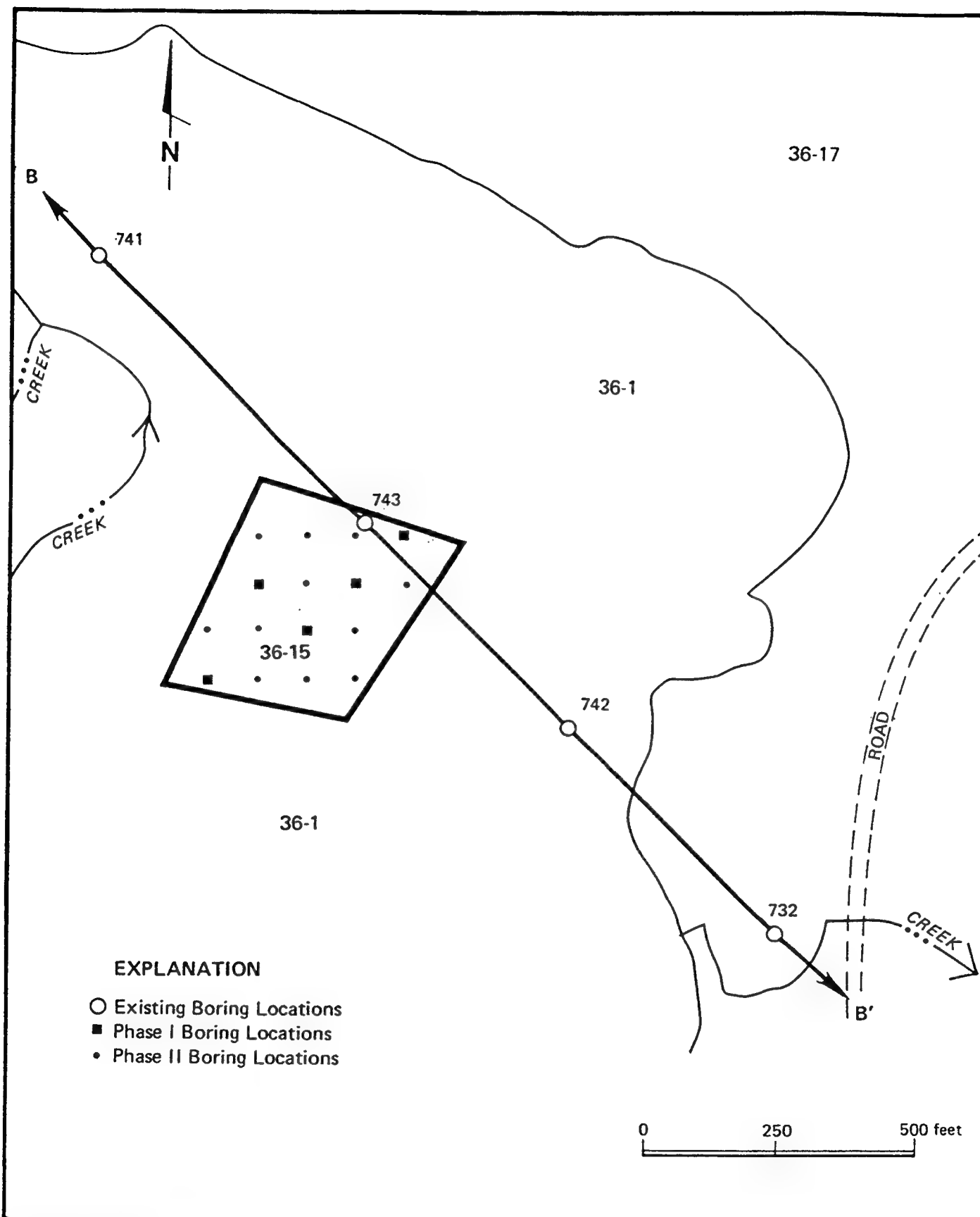


Figure A. 10-1  
 BORING LOCATION MAP  
 CONTAMINANT SOURCE 36-15 (Burning Site)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**

### Hydrogeology

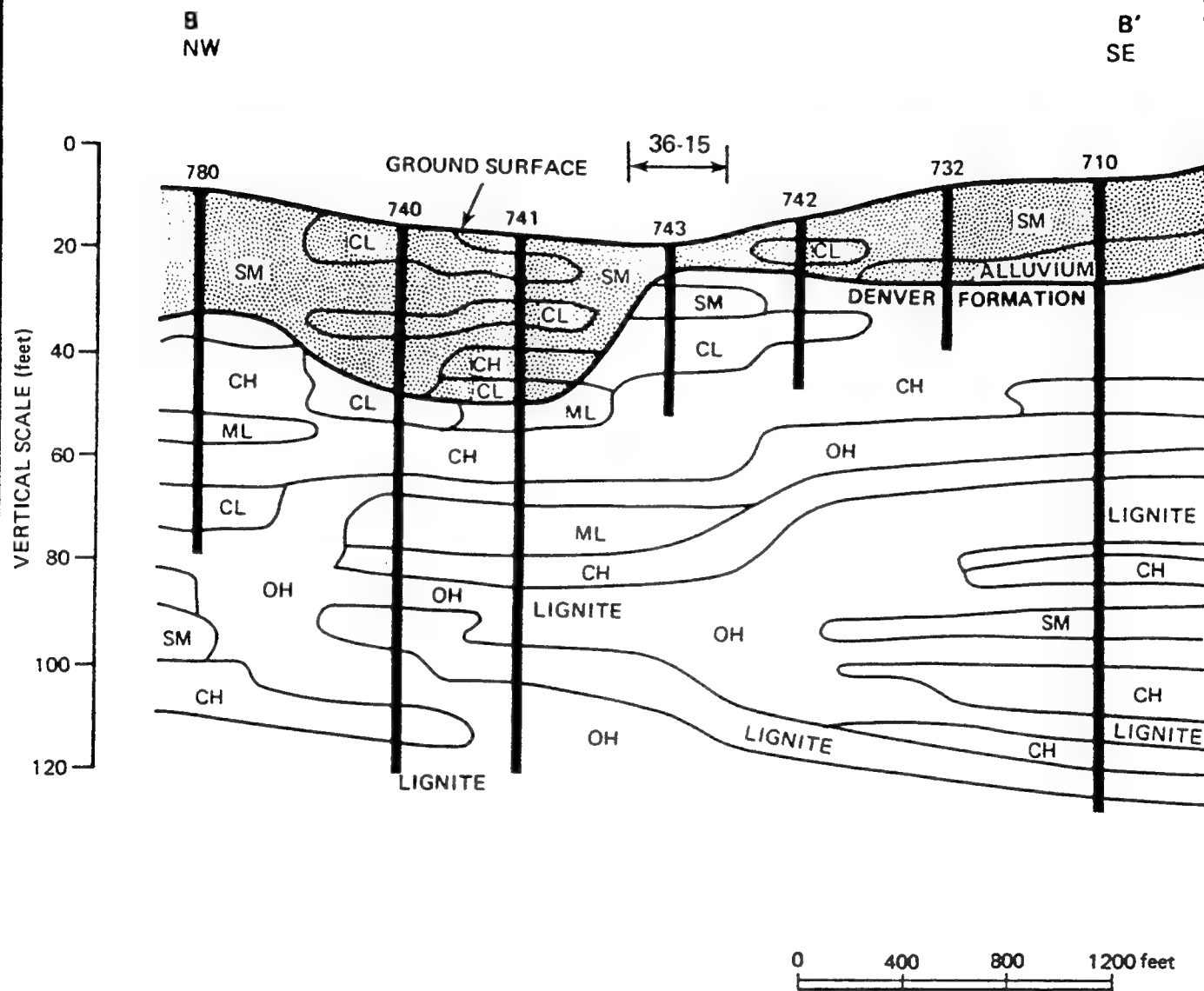
A geologic cross section which cuts through the Burning Site (36-15) is included as Figure A.10-2. The site is located above a bedrock high with alluvial thickness being approximately 10 ft directly below the source. This alluvial material consists of a sandy silt with interbedded clay lenses. The Denver Formation below this site can be divided into an upper and a lower unit. The upper unit at this location consists of interbedded sandy silt, silt, and clay. The lower Denver unit consists of interbedded silt, clay, organic rich clays, and lignite.

This site is located within the eastern portion of Basin A. The direction of ground water flow is to the northwest and the Basin A neck. Ground water in the alluvium in this area contains measureable concentrations of arsenic, DIMP, dieldrin, endrin, and dithiane (DAR, 1984).

### Phase I Program

The Source 36-15 boring program is based on an areal extent of 128,000 ft<sup>2</sup>. A borehole spacing of 90 ft was selected from Figure 3.3-1 yielding a total of 16 borings. During Phase I five boreholes will be constructed. Locations for Phase I boreholes are shown in Figure A.10-1. These locations have been selected using a grid pattern and considering the proposed locations of Phase II boreholes. The Phase I program will collect 11 soil samples according to the following strategy.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
1	10.0 (WT)	3
4	5.0	8



**Figure A. 10-2**  
**CROSS SECTION B-B' THROUGH**  
**CONTAMINATED SOURCE 36-15**  
**ROCKY MOUNTAIN ARSENAL, SECTION 36**  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**



Phase II Program

During the Phase II boring program it is anticipated that an additional 11 boreholes will be constructed. It is expected that the number of borings, specific locations, and sampling intervals may change as a result of Phase I information. The proposed Phase II program will collect a total of 23 soil samples.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
1	10.0 (WT)	3
10	5.0	20

A.11 SOURCE 36-17': COMPLEX DISPOSAL ACTIVITY

This source is characterized by a variety of disposal practices in numerous areas with overlapping boundaries and imprecise history. This site contains both a northern and southern section and is approximately 107 acres in size (Figure A.11-1 and A.11-2). For the most part disposal of solid wastes in trenches and pits has occurred. The following information has been obtained for Source 36-17':

Estimated Areal Extent = 4,685,000 ft<sup>2</sup>

Estimated Vertical Extent = 15 ft

Estimated Volume = 2,603,000 yd<sup>3</sup> (RMACCPMT, 1984)

Revised Areal Extent = 4,764,000 ft<sup>2</sup>

As a result of program changes the areal extent of Source 36-17' has been revised. Program changes include reduction of the scale of investigation at sites 36-9 and 36-16 which are both contained within the perimeter of the northern portion of 36-17'. Sites 36-9 and 36-16 are categorized as an Incendiary and Munitions Test Site and an Incendiary Burn Site, respectively. Both sites are believed to have resulted from Army activities. The reduced investigation at these sites is comprised of considering these location as part of Source 36-17', adding 225,000 ft<sup>2</sup> to the area of this source. This alteration reduced boring densities at these Army sites due to difference in areal extent between 36-9, 36-16 and 36-17'. In addition to this change, the southern portion of 36-17' was reduced in extent by 150,000 ft<sup>2</sup> due to the expansion of Source 36-3'. The revised 36-17' areal extent is cited above.

Disposal History

Disposal activity in this area was observed in the first aerial photograph of Section 36, dated 1948. Activity in this source area continued from this date through 1975. On the 1948 photo several disposal activities have been observed. In the northern portion of Source 36-17' a large bare area existed, but only two trenches were visible. In the center of this northern portion of 36-17', disturbances showed the existence of 8 to 12 trenches. A portion of this area was used for burial of M-17 incendiary devices. The southern portion of this

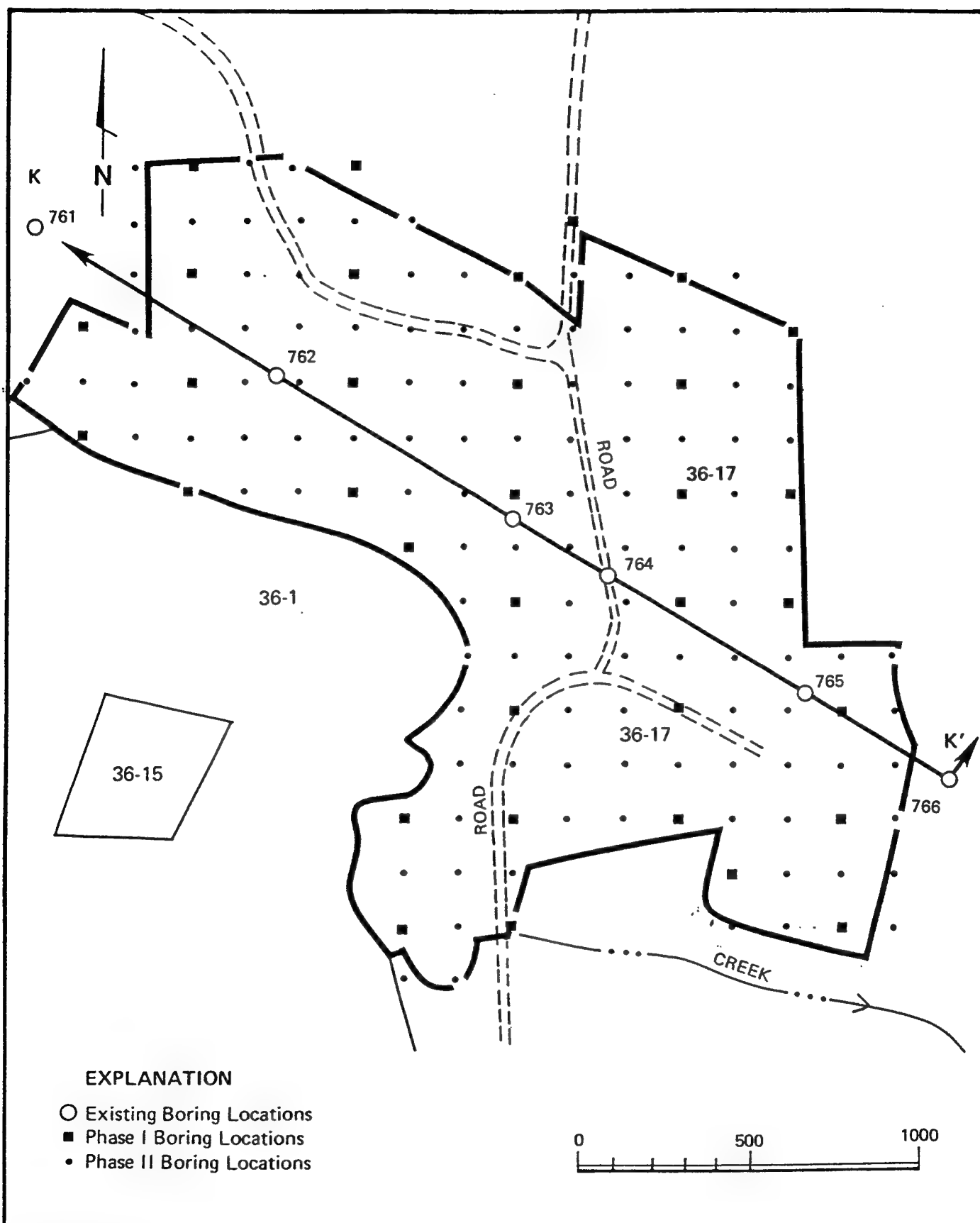


Figure A. 11-1  
 CROSS SECTION K-K' THROUGH  
 CONTAMINATED SOURCE 36-17 NORTH  
 (Complex Disposal Activity/Site)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
 Materials Agency**  
 Aberdeen Proving Ground, Maryland

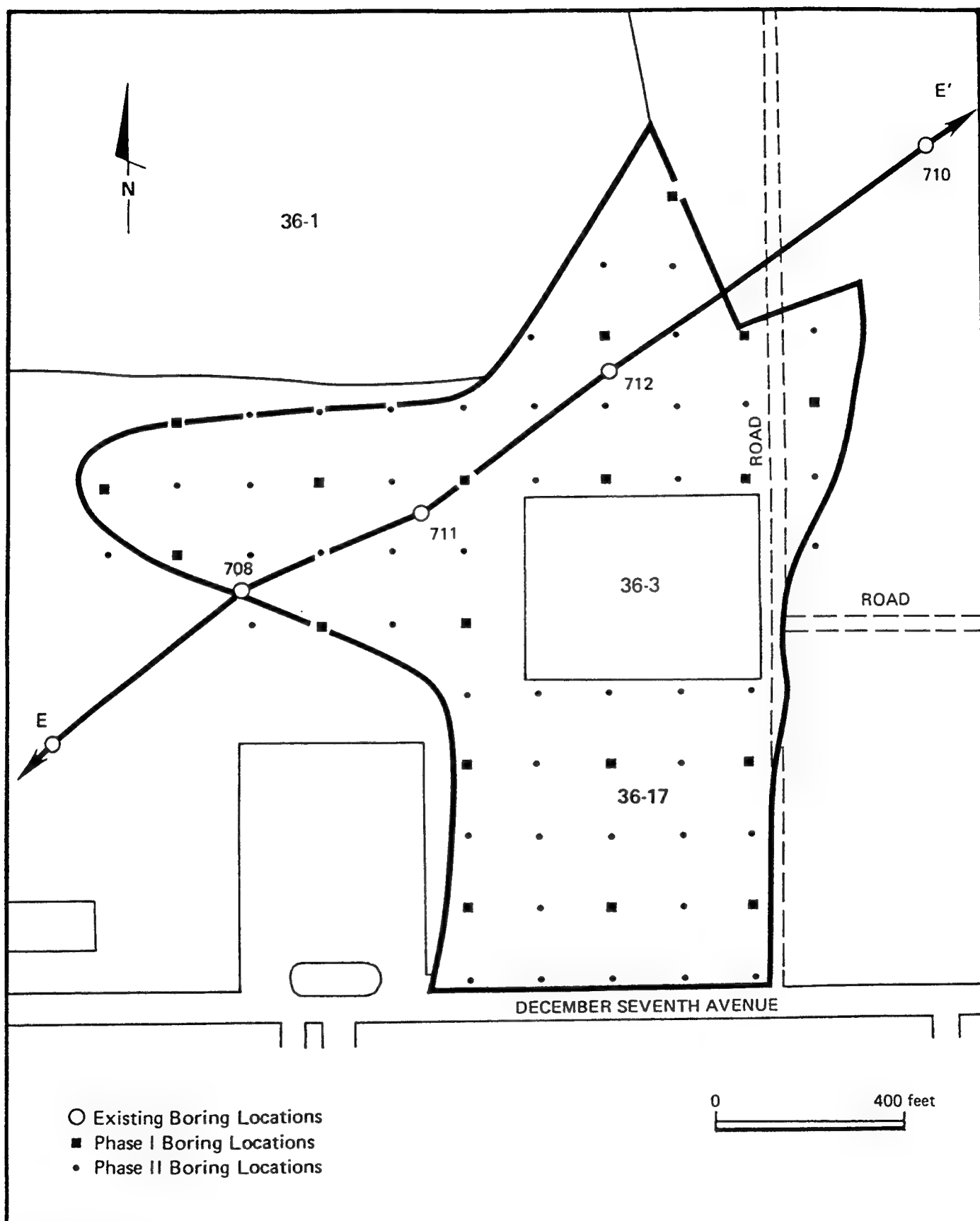


Figure A. 11-2  
 BORING LOCATION MAP  
 CONTAMINATED SOURCE 36-17' SOUTH  
 (Complex Disposal/Activity Site)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

Prepared for:  
 U.S. Army Toxic and Hazardous  
 Materials Agency  
 Aberdeen Proving Ground, Maryland

source remained undisturbed with the exception of activity within the Source 36-3' area where insecticides were being disposed.

The 1950 aerial photograph showed no new activity in the southern portion of this source and minimal activity in the northern portion. The site, which appeared to contain most of the trenches in 1948, appeared to be completely disturbed. The central area of the northern portion of Source 36-17' contained four round pits and four irregular dark patches which were former pools or spills.

The 1953 aerial photo showed increased trenching activity in the northern sector. One new pit and 15 new trenches appeared in the north-northwest portion of this sector. At least 2 new trenches were added in the central portion of the northern sector of 36-17'. Two new disturbed areas were also visible in the northern part of the southern sector.

The 1958 photograph showed no new activity in the southern sector, but many new trenches in the northern sector of 36-17'. At least 6 new pits and 14 new trenches appeared mostly concentrated along the western portion of this source, close to the Basin A high water mark. One large pit and several bare spots also appeared in the western portion of the southern sector of 36-17'. The 1962 photo showed the addition of 11 new trenches and 6 new pits in the northern sector.

The 1975 photo showed new activities occurred in areas already occupied by previous trenches and pits. Therefore, old sites were covered and new ones were cut on a fairly routine basis. In general, half of the new trenches (about 20 trenches and several pits) in the northern sector were further east than the trenches apparent in the 1962 photo.

The inclusion of former Sources 36-9 and 36-16 into the northern portion of 36-17' calls for a brief discussion of activity at these sites.

Source 36-9 was used for the testing and disposal of incendiary munitions. These munitions were ignited on the ground surface and in shallow trenches. Following burning the trenches were backfilled. The

1948 aerial photo shows activity at this site but no new activity is observed from 1950. Source 36-16 was also a primary disposal area for incendiary munitions. Many trenches and pits were observed in aerial photos from 1948 through 1975.

#### Contaminants

The northern portion of Source 36-17' appears to have been used almost exclusively for disposal and destruction of a variety of munitions. These munitions include bursters, bombs, bomblets, incendiary devices, WP grenades, neutralized GB, and other chemical-filled munitions. This area did not appear to be used for pesticide disposal. This assumption is confirmed by chemical analysis of soil samples collected under the OTSG Program. Contaminants found in relatively high concentrations were copper, zinc, arsenic, and mercury. No detectable pesticides were found in soils collected from a borehole to a depth of 17 ft. However, this single sample point does not ensure that pesticide disposal did not occur in this source.

Organic contaminants expected in this source area include mustard, GB, lewisite, and possibly surety materials other than the more common agents. UXO is also expected in some locations.

#### Hydrogeology

This source, located in the eastern half of Section 36, is divided into a northern and southern sector and extends almost the entire length of Section 36. A geologic cross section of the northern sector appears as Figure A.11-3. The center of this sector sits on a bedrock high. Alluvial thickness beneath this site is 20 to 30 ft, with thickest alluvium closest to Basin A. This alluvium is largely silty sand. The underlying Denver Formation consists of interbedded clays, silty sand, and organic rich clays. Ground water flow is generally to the north/northwest. Surface waters may drain towards Basin A in the west and towards First Creek in the eastern portion.

A geologic cross-section of the southern sector of Source 36-17' is shown as Figure A.11-4. Alluvium thickness in this portion of the site is also

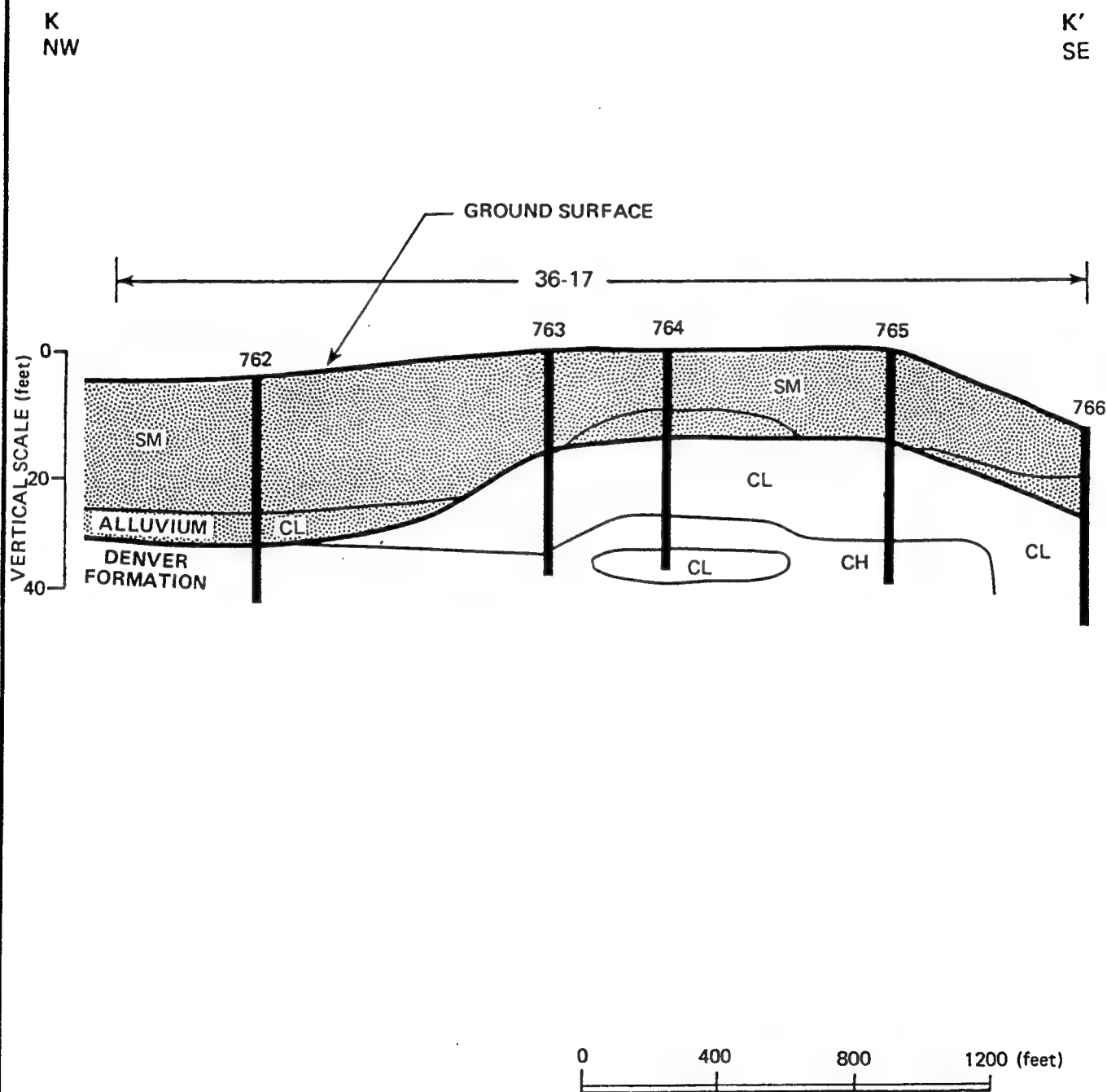


Figure A. 11-3  
CROSS SECTION K-K' THROUGH  
CONTAMINATED SOURCE 36-17' NORTH  
(Complex Disposal Activity/Site)  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

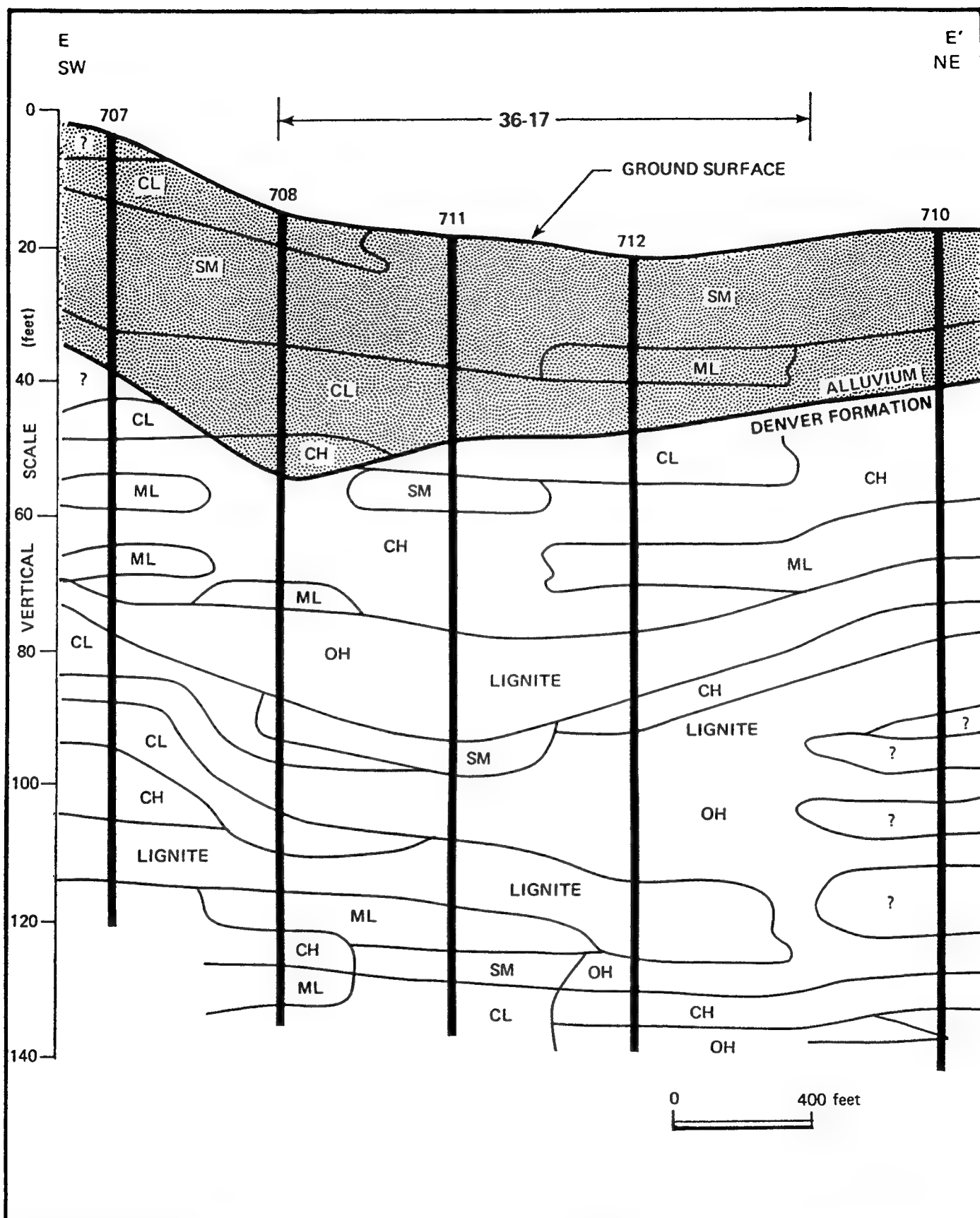


Figure A: 11-4  
 CROSS SECTION T-T' THROUGH  
 CONTAMINATED SOURCE 36-17' SOUTH  
 (Complex Disposal/Activity Site)  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
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20 to 30 ft, but the alluvium consists of interbedded clays and silty sands. The Denver Formation, as in most locations, consists of interbedded silts, silty sands, clays, and organic rich clays. Surface waters drain northeastward towards First Creek from most of this site. Ground water flow is generally to the north.

#### Phase I Program

The estimated total number of borings for both phases in Source 36-17' is 211 based upon an areal extent of 4,764,000 ft<sup>2</sup> and a borehole spacing of 150 ft. Of these, 52 will be constructed under the Phase I Program (Figures A.11-1 and A.11-2). Six borings in the northern sector will be to the water table and are expected to be slightly less than 20 ft deep in central locations. Three borings in the southern sector will also penetrate to the water table, which is expected to be at a depth of 10 ft. All boreholes are arranged in a grid pattern generating 125 samples in this Phase I Program.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
6	20.0 (WT-N)	30
3	10.0 (WT-S)	9
43	5.0	86

#### Phase II Program

The locations, number, and depths of the boreholes for the Phase II study will depend upon interpretation of Phase I data but are tentatively shown in Figure A.11-1 and A.11-2. It is estimated that an additional 159 boreholes will be constructed during the second phase with 356 samples being collected according to the following summary.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
11	20.0 (WT-N)	55
5	10.0 (WT-S)	15
143	5.0	286

#### A.12 SOURCE 36-20': CHEMICAL SEWER

This source was formerly divided into two parts: a northern contaminated sewer still in place and a southern portion where the contaminated sewer has been removed. The northern section extended from the GB Plants south into Section 36 and is not designated for study under this task. The southern section (Figure A.12-1), which will be studied during this task was removed in 1982. It extended from the south central portion of Section 36 westward into Section 35 and ultimately discharged into Basin F in Section 26. The following value has been estimated for the extent of contamination of the southern section.

Estimated Areal Extent = 4,000 ft<sup>2</sup>

#### Disposal History

The southern section of Source 36-20' was constructed of vitrified clay pipe and was used to carry chemical wastes from the manufacturing areas to Basin F.

#### Contaminants

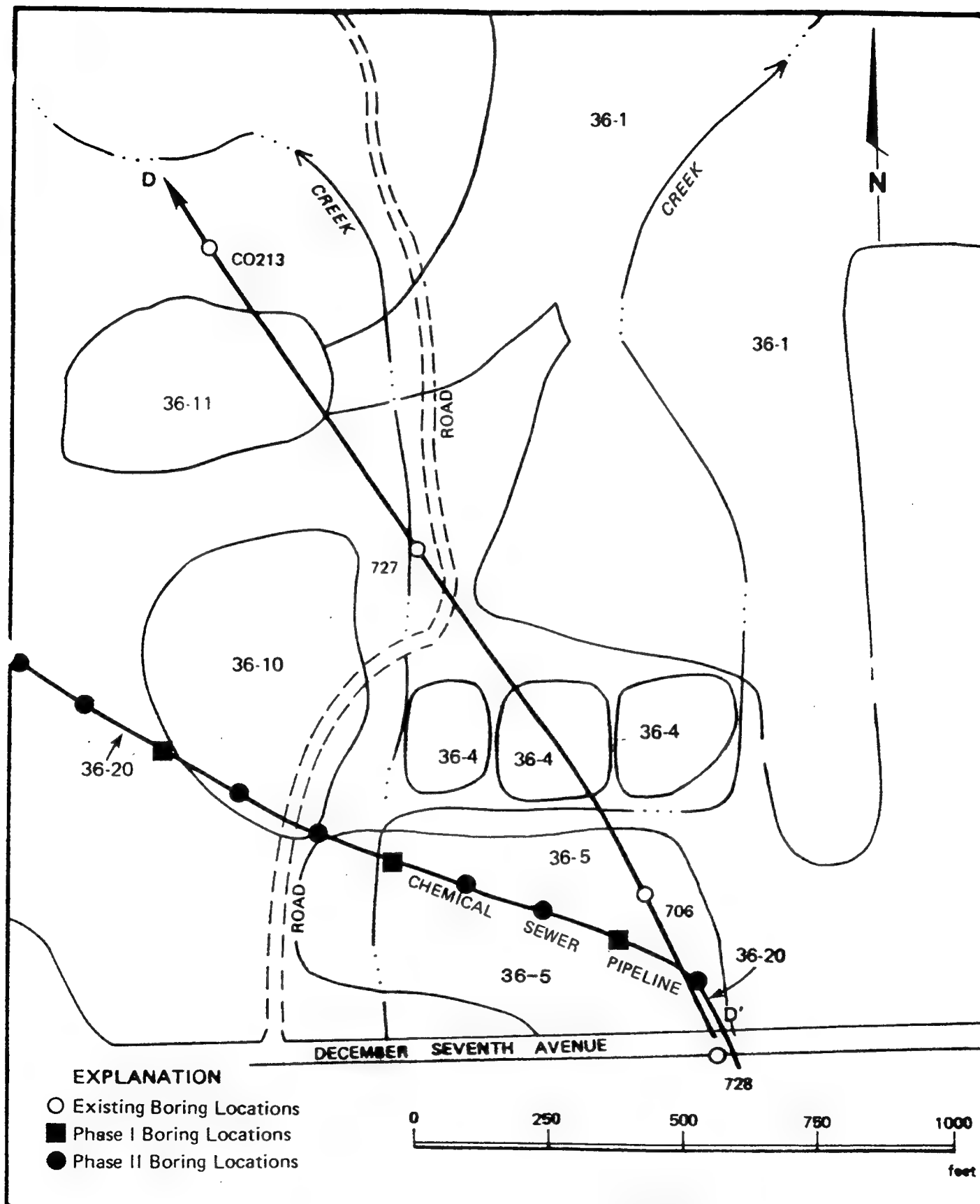
The southern chemical sewer line carried a variety of chemicals discharged by Shell and includes:

Aldrin	Supona
Dieldrin	Vapona
DBCP	Azodrin
Planavin	Parathion

Several studies revealed many leaks along the chemical waste line between the South Plants Area and Basin F. Mixing of the chemical wastes with soils and ground water along the sewer line is probable, although quantities and extent are unknown.

#### Hydrogeology

The remnant of the southern sewer line section lies in alluvium along a northwest trending channel in the Denver Formation. The cross section in Figure A.12-2 shows depth to the Denver Formation at existing Boring Location 706 to be 20 ft. Both ground water and surface waters flow to the north.



**Figure A. 12-1**  
**BORING LOCATION MAP**  
 CONTAMINANT SOURCE 36-20 SOUTH  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
 Prepared by Harding Lawson Associates

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
 Aberdeen Proving Ground, Maryland

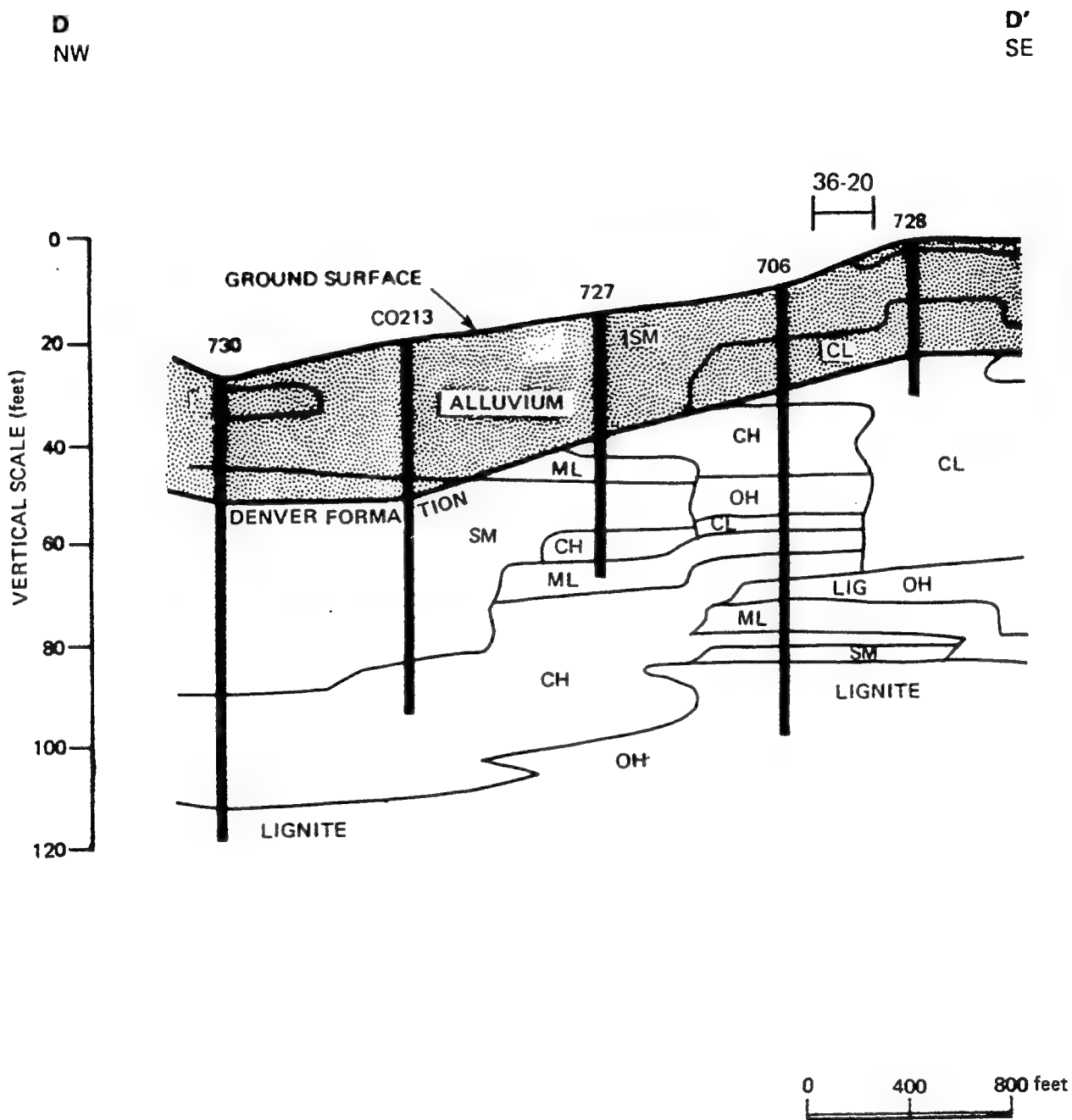


Figure A. 12-2  
 CROSS SECTION D-D' THROUGH  
 CONTAMINATED SOURCE 36-20 SOUTH  
 ROCKY MOUNTAIN ARSENAL, SECTION 36  
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Phase I Program

Based on an areal extent of 4,000 ft<sup>2</sup> a total of 10 borings will be constructed. The Phase I Program calls for 3 borings all of which will be constructed to the water table which is expected to be at a depth of 10 ft. Tentative boring locations are shown in Figure A.12-1. A total of 9 samples will be collected during Phase I.

Phase II Program

Seven borings for the Phase II Program are anticipated. The locations and actual depths will be determined after analysis of Phase I data but it has been estimated that 3 borings will be to 10 ft and the remaining 4 to depths of 5 ft.

#### A.13 SOURCE 36-21': DRAINAGE DITCH

This suspected source was located upon evaluation of aerial photograph interpretation. This site, shown in Figure A.13.1 is primarily a drainage ditch which is immediately east of large storage tanks on the southern edge of Section 36 and runs from 7th Avenue to the north. The estimated areal extent was determined to be 16,000 ft<sup>2</sup>. This ditch may have contained liquids, however, this is undocumented.

##### Disposal History

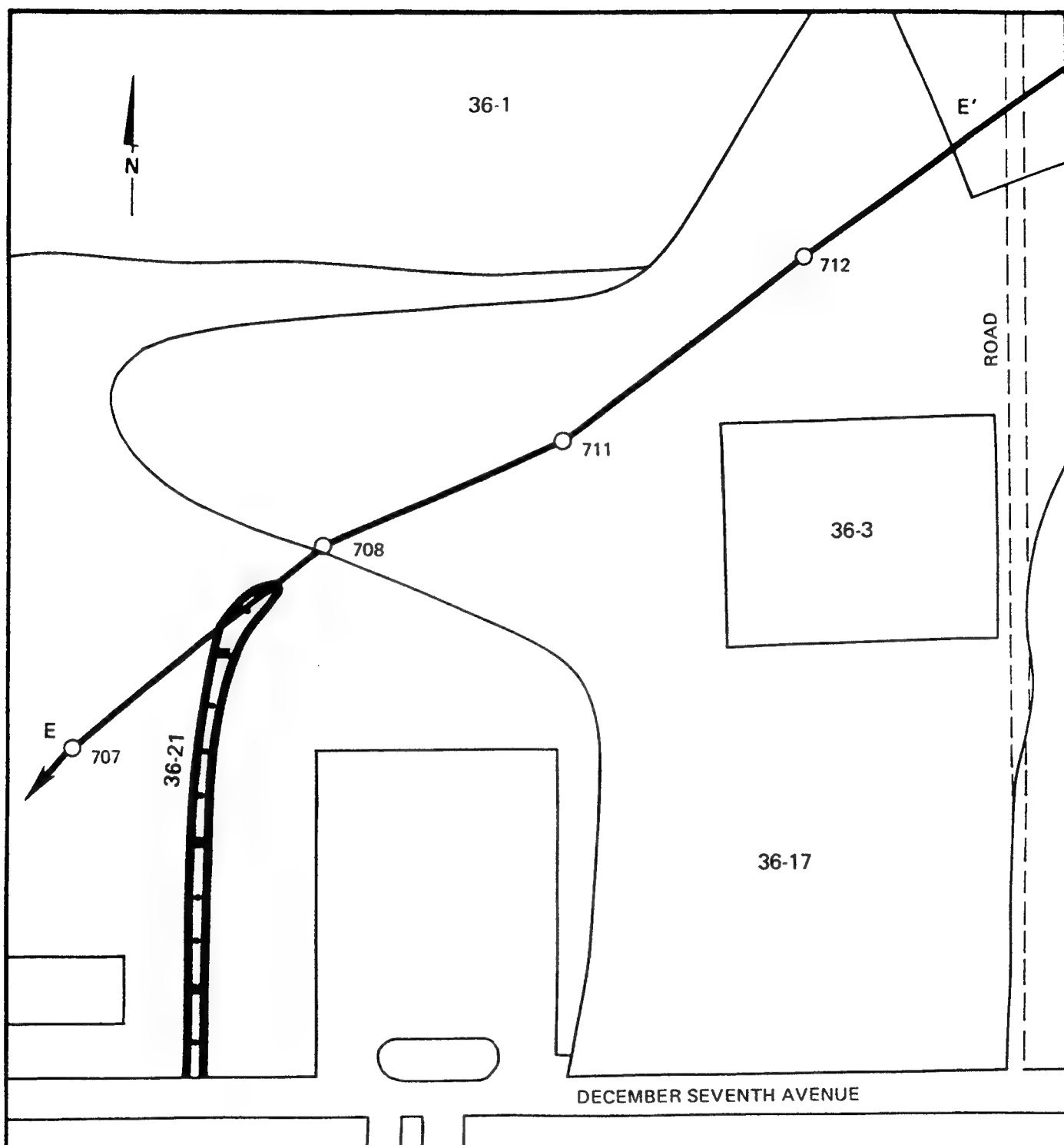
Limited information on the disposal history at this suspected site is available. This location was classified as a site to be investigated based upon aerial photo interpretation from a 1975 photo. In this photograph two large storage tanks have appeared along the north side of 7th Avenue. A long ditch is observed to run north for approximately 500 ft from the eastern edge of these tanks. In addition to this ditch the portion of this site furthest north contains two trenches and two pits. Two liquid pools have also been identified within the 36-21' area.

##### Contaminants

No data is available on the contaminants which may be present at this location. Due to the close proximity to the South Plants Area, soils at this location could possibly contain a wide range of organic and inorganic contaminants. Although no specific information is available, the strategy of the two-phased sampling and analysis plan should identify contaminants if present above certified detection limits. No surety material or UXO is expected at this location.

##### Hydrogeology

A geologic cross section which cuts through the northern end of this site is pictured as Figure A.13-2. The thickness of the alluvium is approximately 20 ft. A silty sand lies beneath this source which is in turn underlain by alluvial clay. The Denver Formation is comprised of interbedded clay, silt, and sand.



#### EXPLANATION

- Existing Boring Locations
- Phase I Boring Locations
- Phase II Boring Locations

0 400 feet

Figure A. 13-1  
BORING LOCATION MAP  
CONTAMINANT SOURCE 36-21'  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

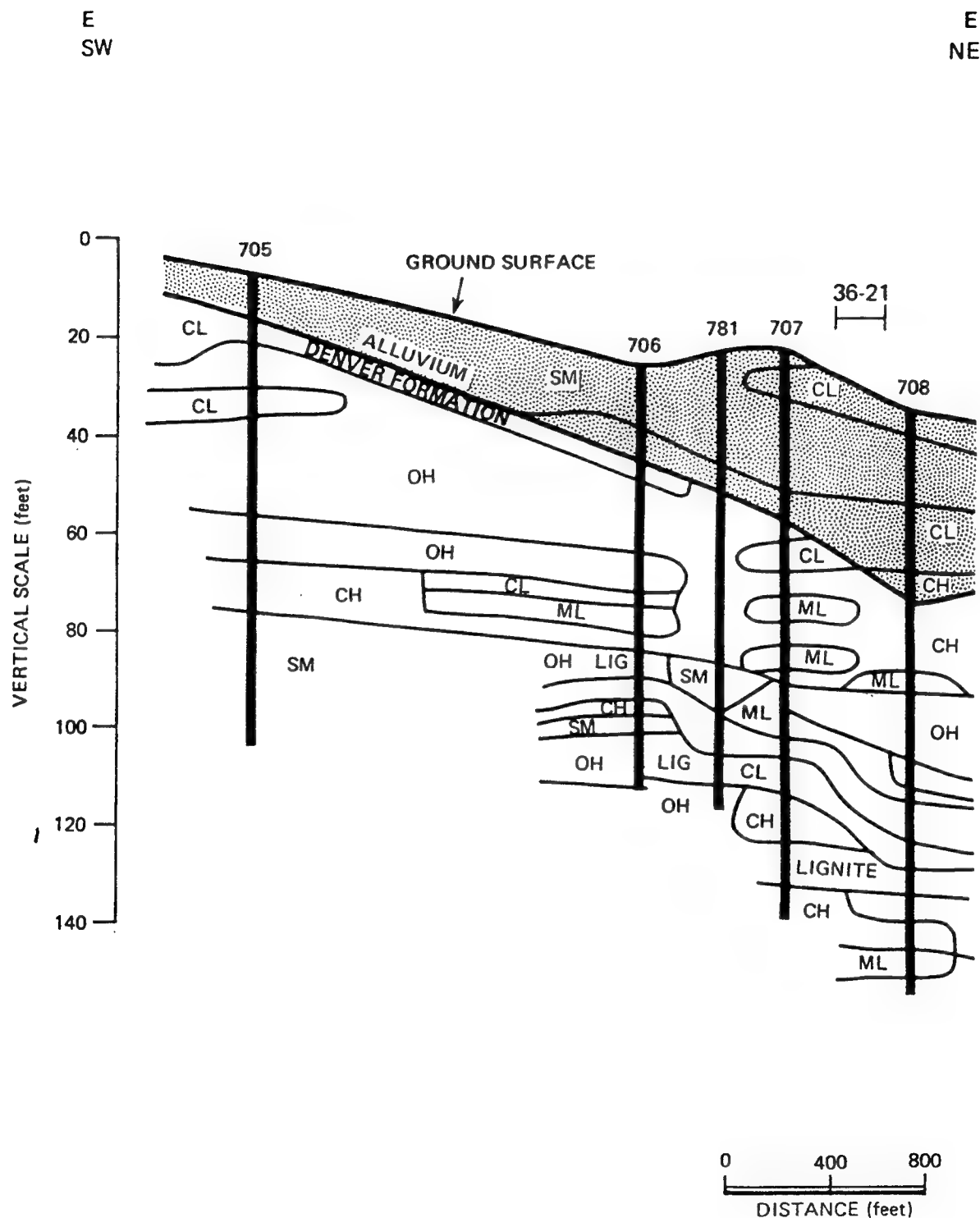


Figure A. 13-2  
CROSS SECTION E-E' THROUGH  
CONTAMINATED SOURCE 36-21'  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

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U.S. Army Toxic and Hazardous  
Materials Agency  
Aberdeen Proving Ground, Maryland



Phase I Program

Based upon an areal extent of 16,000 ft<sup>2</sup> a total number of 10 boreholes have been designated for this location. Three of these 10 boreholes will be constructed during the Phase I investigation. Locations of Phase I boreholes are shown in Figure A.13-1. A total of 7 soil samples will be collected during Phase I. A single boring to 10 ft (water table) and 2 borings to 5 ft comprise the Phase I program.

Phase II Program

The Phase II program, tentatively proposed for this site consists of 7 additional boreholes to be constructed at locations shown in Figure A.13-1. A single boring is designated to penetrate to the water table (10 ft) while the remaining 6 borings will be to depths of 5 ft. A total of 15 soil samples will be collected during Phase II.

#### A.14 SOURCE 36-22': LIQUID STORAGE POOL

This site was originally identified as a liquid storage pool (Figure A.14-1) during interpretation of aerial photographs. In this interpretation Source 36-11 was termed the southern storage pool and Source 36-22' was termed the northern pool. However, estimates of the areal extent of Source 36-11 were for the southern pool only. Contaminant source maps of Section 36 do not show this northern pool. Aerial photo interpretation show this liquid storage pool to have contained liquids similar in composition to those liquids at Source 36-11 and Basin A. Therefore, investigation of this site has been proposed and detailed. The areal extent of this site has been estimated at 180,000 ft<sup>2</sup>.

##### Disposal History

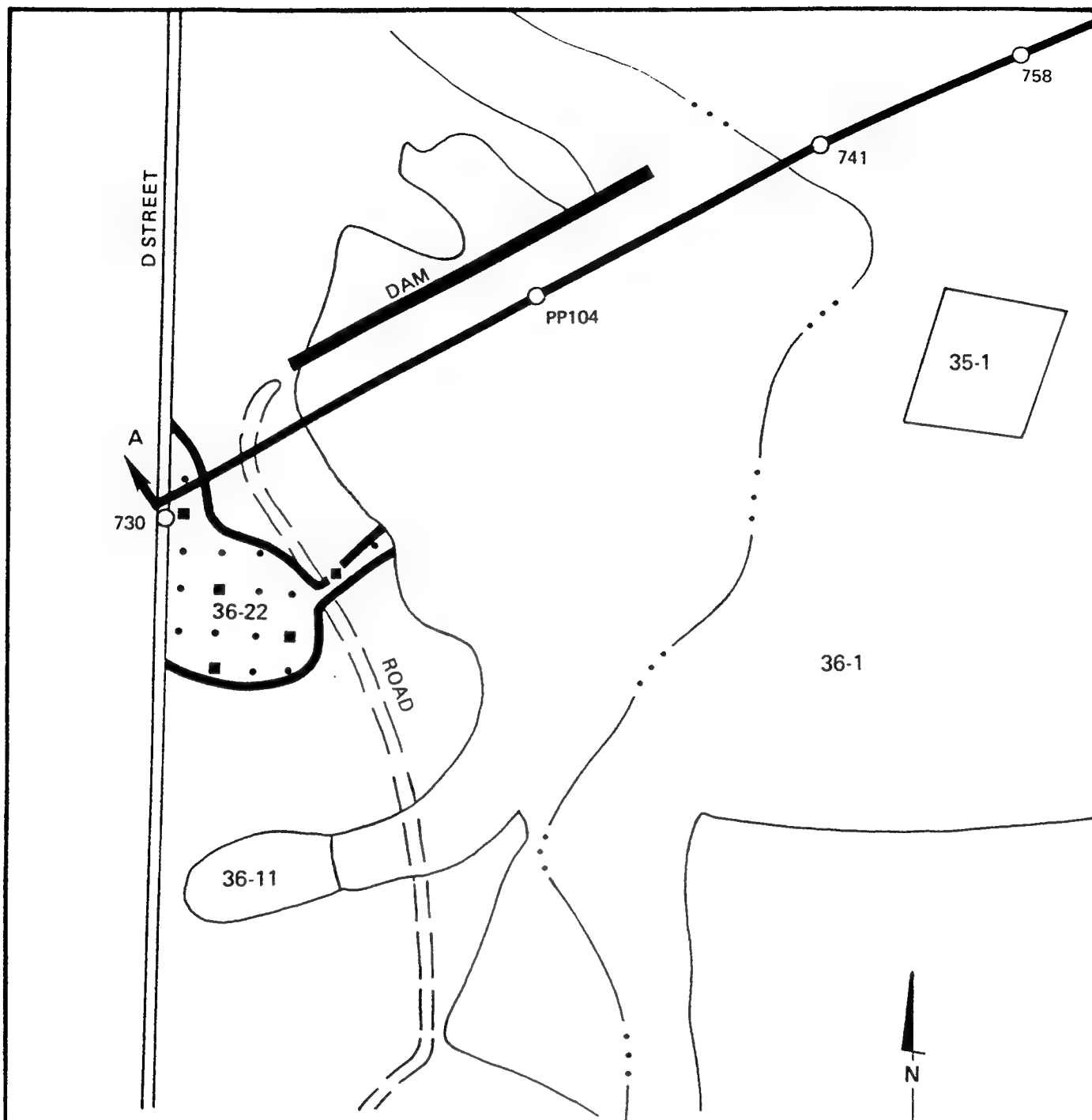
The 1953 aerial photograph first shows the existence of this pool on the western border of Section 36. The pool appears to cover an area of approximately one acre with a high water mark of 2 acres. This pool remains essentially unchanged through 1958, but by 1962 this area has almost totally dried up. In this 1962 photo a small pool exists at the center of this suspected source and a ditch now exists between this pool and Basin A. There was no additional site activity observed after 1962.

##### Contaminants

As it appears that this pool was hydrologically connected to or drained into Basin A, it is expected that potential contaminants at this site would be similar to those for Source 36-1' and 36-11. Therefore contaminants may include pesticides, insecticides, volatile organics, and metals. It is not expected that surety material or UXO are present at this site.

##### Hydrogeology

A geologic cross section in the vicinity of this site is pictured as Figure A.14-2. The site is underlain by alluvium of approximately 20 ft in thickness. This alluvium consists of interbedded clay and silty sand. The water table is expected in the alluvium at the depth of approximately 10 ft.



#### EXPLANATION

- Existing Boring Locations
- Phase I Boring Locations
- Phase II Boring Locations

0 1000 feet

Figure A. 14-1  
BORING LOCATION MAP  
CONTAMINANT SOURCE 36-22'  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

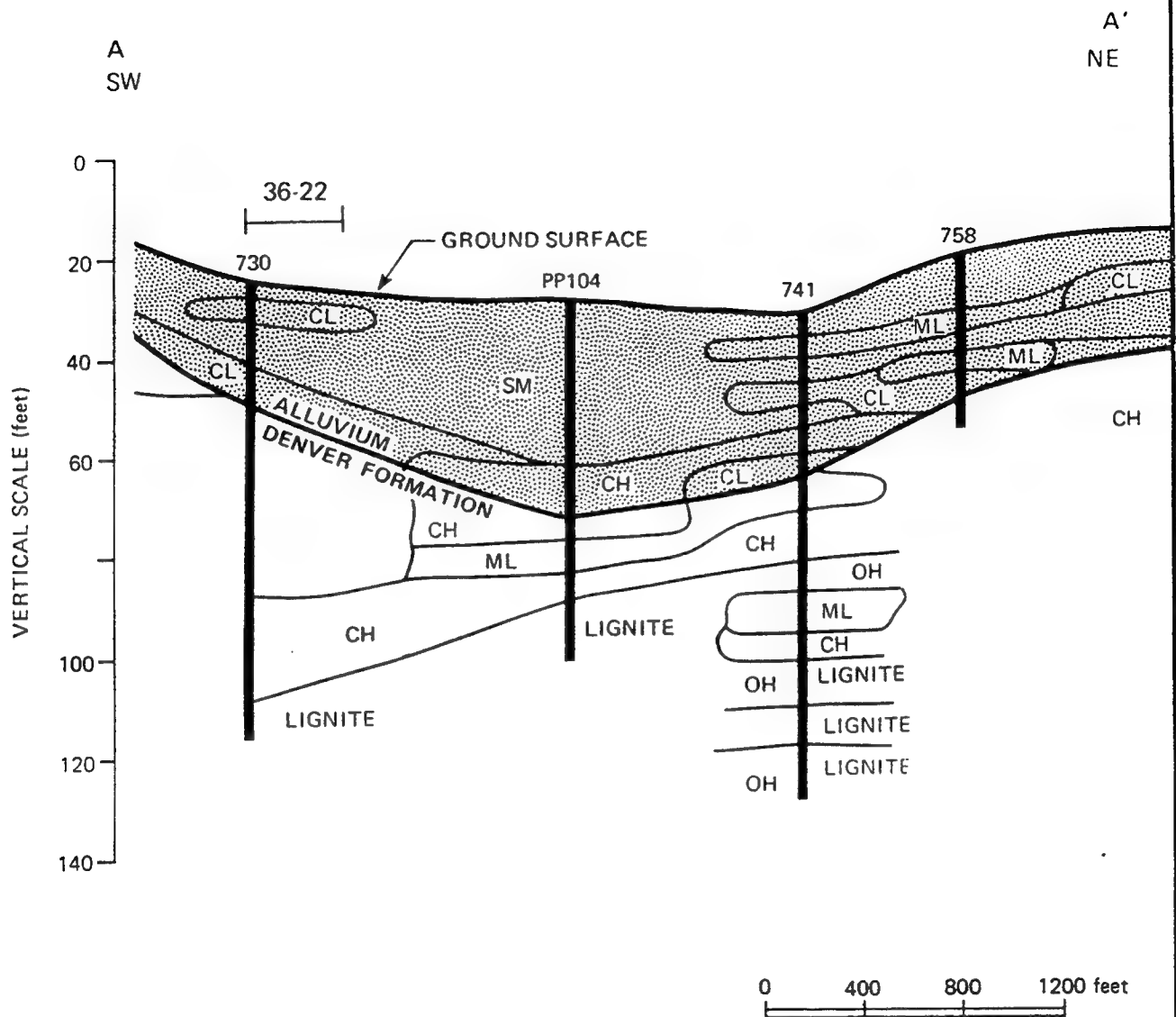


Figure A. 14-2  
CROSS SECTION A-A' THROUGH  
CONTAMINATED SOURCE 36-22'  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

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Materials Agency**  
**Aberdeen Proving Ground, Maryland**

Surface drainage is toward the east and Basin A at this location. The ditch observed in the 1962 aerial photo was apparently constructed to connect this pool with Basin A.

#### Phase I Program

Based upon an areal extent of 180,000 ft<sup>2</sup> and Figure 3.3-1, a borehole spacing of 100 ft was selected. This results in a total of 18 borings at this site with 5 boreholes to be constructed during the Phase I investigation. Eleven samples are to be collected at the 5 boreholes shown in Figure A.14-1. A summary of this program follows.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
1	10.0 (WT)	3
4	5.0	8

#### Phase II Program

The proposed Phase II program would fill in gaps in the Phase I grid pattern by placing 13 boreholes in locations shown in Figure A.14-1. A total of 27 soil samples will be collected according to the following summary.

<u>Number of Borings</u>	<u>Depth (ft)</u>	<u>Samples</u>
1	10.0 (WT)	3
12	5.0	24

The locations, depths, and number of samples collected from these borings may be altered following interpretation of Phase I data.

#### A.15 UNCONTAMINATED AREAS

Approximately one-half of the total area of Section 36 is not included within designated contaminant source boundaries. This area totals 15,079,200 ft<sup>2</sup> and is shown in Figure A.15-1. Interpretation of aerial photographs have not shown surficial disturbances in these areas nor have RMA records indicated that any of these areas were utilized for liquid or solid waste disposal.

In order to confirm that these areas are in fact "uncontaminated" or free of significant contamination, additional soil boring and sampling are proposed throughout this area. Construction of boreholes in these areas will be performed during the Phase I investigation. Based on previous experience and best professional judgement a borehole spacing of 500 ft was selected for this area. The borings will be arranged in a grid pattern as shown in Figure A.15-1. A total of 60 borings will be constructed. Although such a low density of borings may not detect smaller additional sources, it is anticipated that data from this program will establish if such additional areas exist and approximate locations. If contamination is detected, follow-up studies may be performed in conjunction with the Phase II investigation. Investigations for Army only sources designated to be performed during Task 10 are scheduled to commence in December 1985.

All sampling in these areas will involve the collection of a single 5 ft core in each designated location. The 5 ft core will be examined and logged to determine if visual subsurface disturbances have occurred at each location. The geologist examining and logging the core will look for evidence of disturbed stratigraphic horizons as well as for the presence of soil discoloration or debris. For each 5 ft core a single composite soil sample will be submitted to the laboratories for a chemical analyses scan identical to that for all other samples collected during the Phase I investigation. The single composite soil will be prepared in the laboratory from 0-1.0 ft and 4.0-5.0 ft soil sampling intervals specified in Section 3.5.1.1. It is not anticipated that Phase II sampling will be necessary in "uncontaminated" areas.

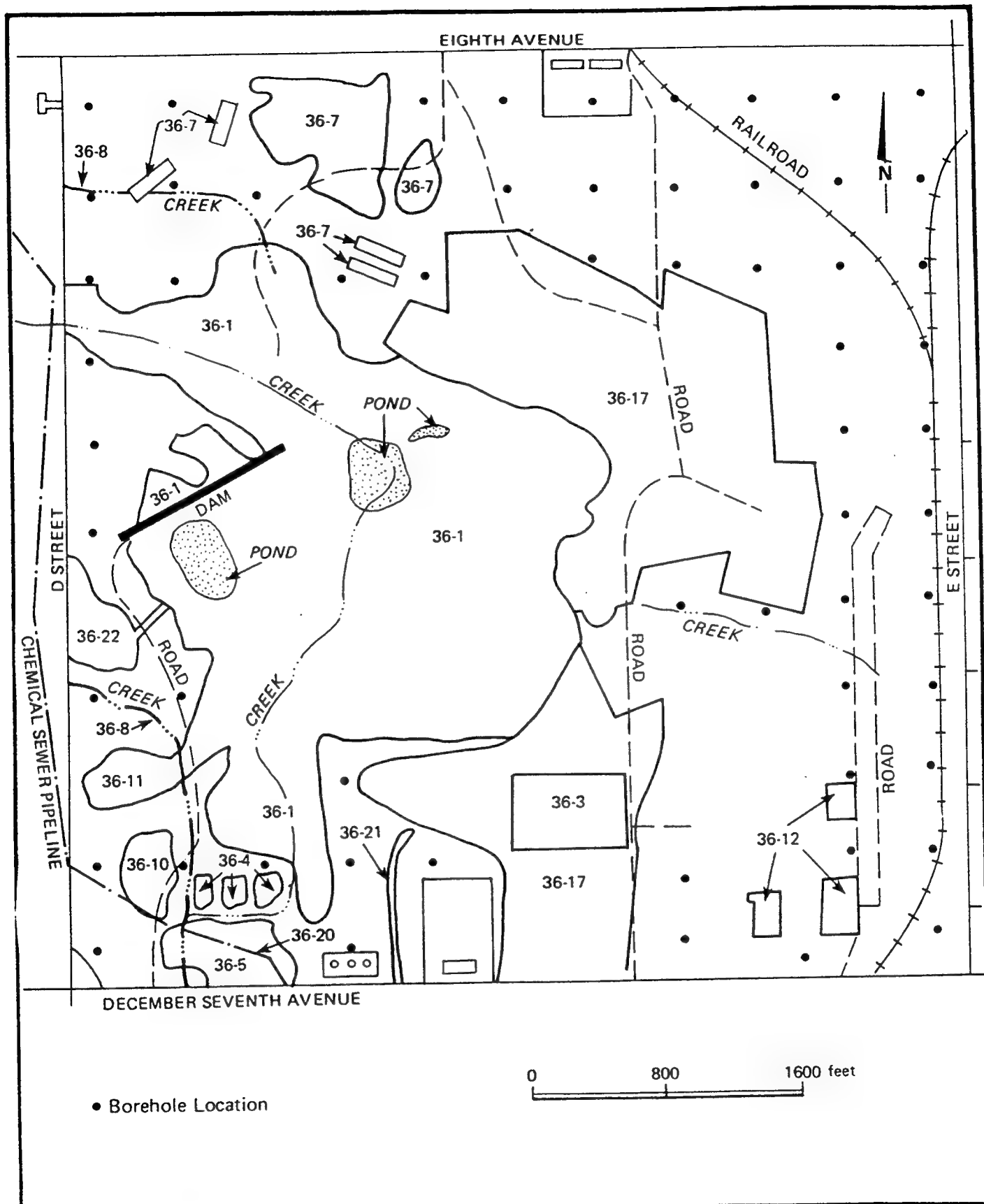


Figure A. 15-1  
BOREHOLE LOCATIONS IN  
"UNCONTAMINATED" AREAS  
ROCKY MOUNTAIN ARSENAL, SECTION 36  
Prepared by Harding Lawson Associates

Prepared for:  
**U.S. Army Toxic and Hazardous  
Materials Agency**  
Aberdeen Proving Ground, Maryland

APPENDIX B

FIELD AND LABORATORY  
QUALITY ASSURANCE PLAN  
ROCKY MOUNTAIN ARSENAL  
LITIGATION SUPPORT AND SERVICES

CONTRACT DAAK11-84-D-0016

(Revised 1/14/85)



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## 1.0 INTRODUCTION

This document is the Project Quality Assurance (QA)/Quality Control (QC) Plan for sampling and analyses performed on tasks assigned under Contract DAAK11-84-D-0016 for "Litigation Technical Support and Services--Rocky Mountain Arsenal." These tasks require compliance with the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) QA Program of April 1982. This plan is based on and, in general, complies with this USATHAMA QA Program. Deviations from USATHAMA QA procedures, where they occur, have been approved by USATHAMA and are indicated as deviations in the text. Specific details and deviations from this general plan, if any, for a certain task or survey will be described in detail in the Task Sampling and Analysis Plan or test plans. This plan will be implemented by ESE and all subcontractors performing sampling and analytical services.

The specific objectives of this plan are to describe in general detail the processes for controlling the validity of the data generated in the sampling and analysis efforts; the methods and criteria for detection of out-of-control situations; steps to be taken to provide timely corrective action; and how such actions will be reported and documented. The Project QA/QC Plan also supports the Data Management Plan by providing documentation of the limits of precision, accuracy, and sensitivity of all analytical systems generating data and by providing mechanisms for documentation of the validity of all reported data.

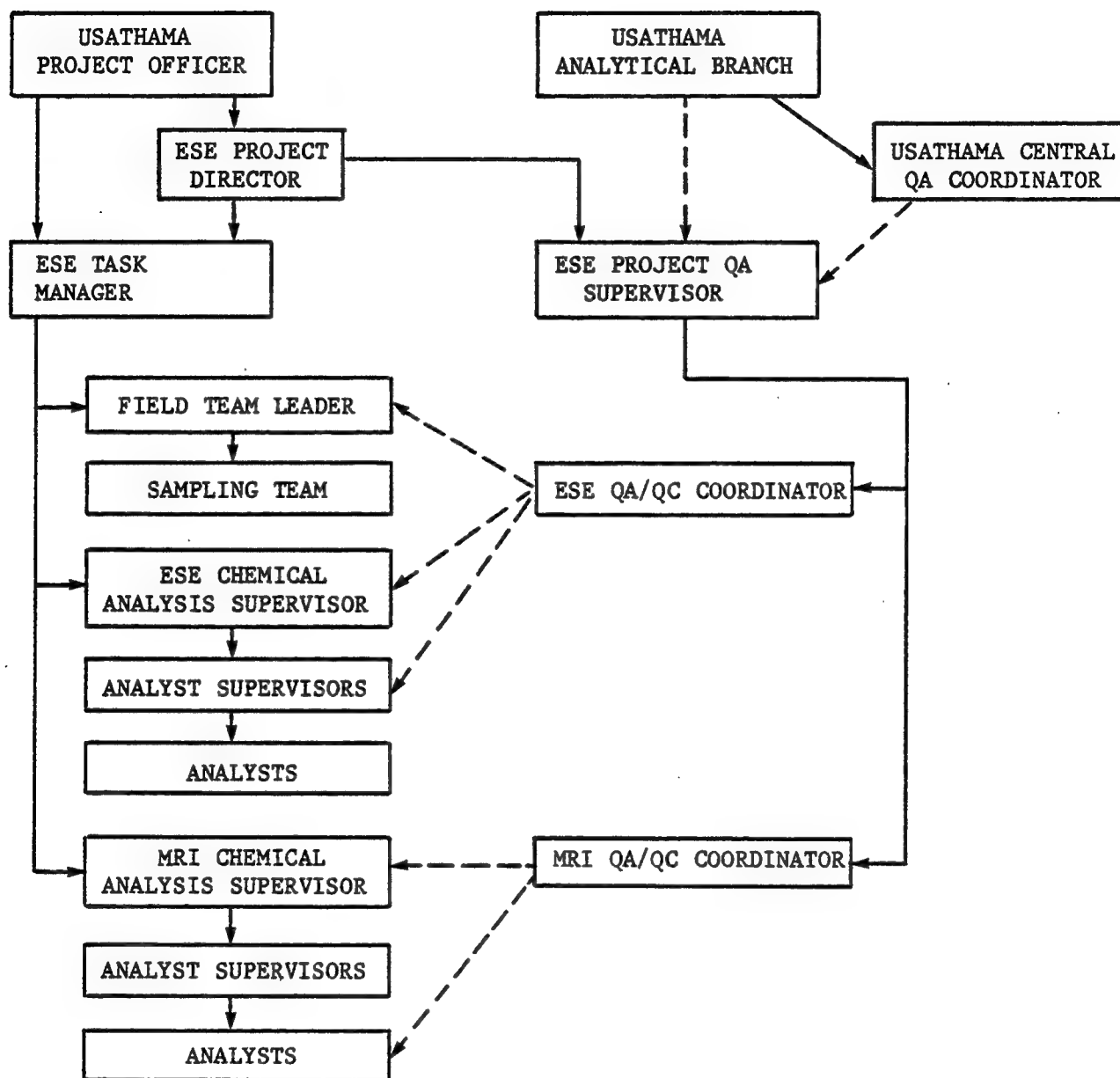
Some survey tasks may require the development and documentation of certain semiquantitative and quantitative analytical methods for all phases of the project. The analytical systems controls and data validation procedures described in this QA/QC Plan will be employed to ensure valid, properly formatted data defining the precision, accuracy, and sensitivity of each method.

## 2.0 QA ORGANIZATION AND RESPONSIBILITIES

This QA/QC Plan functions according to the USATHAMA central-laboratory/field-laboratory concept. Environmental Science and Engineering, Inc. (ESE) and its subcontractor laboratory, MRI, act as the field laboratories, which are monitored by the USATHAMA Central Laboratory QA Coordinator. The overall QA/QC organization is shown in Fig. 2.1-1. The function of the plan and QA responsibilities of each of the project participants are outlined in the following subsections.

Fig. 2.0-1 depicts the manner in which the Project QA Supervisor monitors the conduct of the sampling and analytical effort. The Project QA Supervisor is not directly subordinate to anyone responsible for sampling and analysis and reports only to the Project Director. The Project QA Supervisor oversees the performance of the QA/QC Coordinators in the ESE and MRI laboratories. The QA/QC Coordinators monitor the chemical analysis effort in their respective laboratories to ensure compliance with USATHAMA QA requirements and those of the Project QA/QC Plan. The QA/QC Coordinator also audits and monitors field sampling activities.

The general manner in which the QA/QC Plan functions in each laboratory in terms of data review and monitoring is shown in Fig. 2.0-2. The analyst performs the analysis of samples and control samples and plots QC sample results on control charts. The data are then processed through the Data Management System, where automated QC checks are performed, and the data are presented in standard laboratory and USATHAMA format. The Analyst Supervisor then reviews and approves the data. The Task Chemical Analysis Supervisor then reviews and approves the data and QC results and submits the data batch to the Laboratory QA/QC Coordinator for review. The Laboratory QA/QC Coordinator reviews the data and monitors QC results and compliance with QA Plan requirements. The data may be returned to the Chemical Analysis

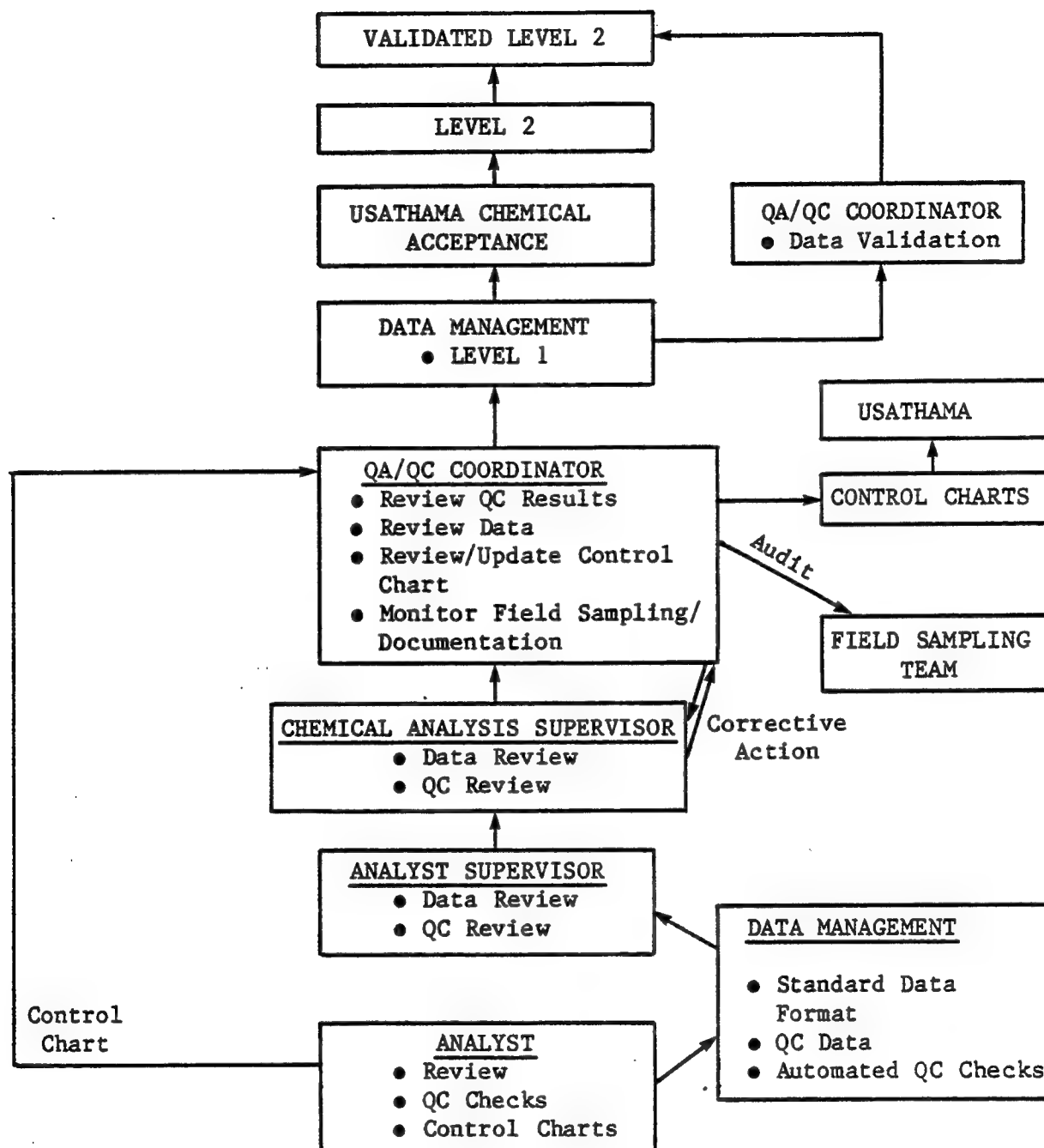


--- Auditing and Monitoring Activities.  
— Line of Authority.

SOURCE: ESE, 1985.

Figure 2.0-1  
PROJECT QA/QC ORGANIZATION

Prepared for:  
U.S. Army Toxic and Hazardous  
Materials Agency  
Aberdeen Proving Ground, Maryland



SOURCE: ESE, 1985.

Figure 2.0-2  
QA/QC PLAN FUNCTIONS--  
DATA FLOW AND QC CHECKS

Prepared for:  
U.S. Army Toxic and Hazardous  
Materials Agency  
Aberdeen Proving Ground, Maryland

Supervisor at this time for any necessary actions to correct QC deficiencies.

The QA/QC Coordinator is also responsible for updating and reviewing control charts. After QA/QC review, the data batch is returned to the Data Management System for final processing, storage, and transmittal to the USATHAMA Installation Restoration Data Management System (IR-DMS) system. After entry into the IR-DMS at Level 1, the USATHAMA Chemical Acceptance Program is applied to the data. After the data batch passes the Chemical Acceptance Program, the data may be elevated to Level 2 into the IR-DMS. After the data are in Level 1, the Laboratory QA/QC Coordinator begins the process of validation of the chemical data. The validation process verifies the accuracy and transcription of a data subsample. When the validation process is completed, the Level 2 data are designated as validated in the IR-DMS system.

The QA/QC Coordinator monitors the field sampling effort by regulating the logging-in of samples, checking copies of field notebook entries and logsheets, and observing field sampling procedures and reporting any inconsistencies and/or omissions to the Field Team Leader. The QA Supervisor also monitors the QC and calibration data submitted to support field tests and analysis.

## 2.1 QA/QC RESPONSIBILITIES OF THE PROJECT TEAM

### 2.1.1 PROJECT DIRECTOR

The Project Director serves in the QA function as a primary technical reviewer of project deliverables. He also reviews work plans, schedules, costs, technical performance, and works with the Task Manager to redirect resources to achieve contractual obligations. The Project Director also provides authority in support of the Project QA Supervisor in the performance of his duties.



01/18/85

#### 2.1.2. PROJECT QA SUPERVISOR

The Project QA Supervisor is responsible for maintaining and overseeing an effective QA/QC organization in each laboratory and organization performing chemical analysis or sampling on the assigned task. The Project QA Supervisor directly supervises the performance of the QA/QC Coordinator and audits the performance of the MRI QA/QC Coordinator to ensure that the requirements of the Project QA/QC Plan are followed in sampling and analysis activities. The Project QA Supervisor directs the development of the Project QA/QC Plan and approves any deviations or changes to QA/QC requirements. USATHAMA Analytical Branch and the COR must approve of any changes to the QA/QC program. He maintains liaison with the Task Team and the USATHAMA Analytical Branch.

#### 2.1.3 QA/QC COORDINATOR

A QA/QC Coordinator is assigned by the Project QA Supervisor to each laboratory performing chemical analyses. The QA/QC Coordinator is responsible for monitoring and documenting the quality of all data reported to USATHAMA by the laboratory. The QA/QC Coordinator's specific responsibilities are:

1. To provide an independent overview of the QC practices within his respective organization to ensure that all QC requirements of the project QA Plan are completed;
2. To maintain and review all QC records, including control charts, and to provide copies of QC records to USATHAMA on a weekly basis;
3. To prepare those sections of all interim and final project reports dealing with QC data;
4. To establish testing lots (batches) in coordination with the Chemical Analysis Supervisor and to ensure the introduction of appropriate control samples in each lot;
5. To monitor the logging-in of samples, as well as sample preservation, handling, subsampling, and transport throughout the project;

6. To review all data batches for proper QC procedures and to audit data files for correct entry of all data and approve all data upon transmittal to Level 2;
7. To obtain and maintain records on Standard Analytical Reference Material (SARM) or interim reference materials;
8. To maintain a vigil of the entire laboratory and field operation to detect conditions which might jeopardize control of the various analytical and sampling systems;
9. To ensure by field visits that appropriate sampling, field testing, and field analysis procedures are followed and that correct QC checks are being made;
10. To inform the project management and the Project QA Supervisor concerning nonconformance with the QA program and provide documentation of said nonconformance, to recommend the corrective actions that are to be taken, and to document their completion; and
11. To maintain and update records of the qualifications of the analysts and field team members.

#### 2.1.4 TASK MANAGER

The Task Manager is responsible for effective day-to-day management of the total project staff, as well as direct communication and liaison with the USATHAMA COR. The Task Manager's responsibility specific to QA/QC is to approve all QA/QC procedures to be used in the conduct of the project, to provide additional authority when required to support the Project QA Supervisor, and to approve of any revisions to the project QC Plan.

#### 2.1.5 CHEMICAL ANALYSIS SUPERVISOR

The Task Chemical Analysis Supervisor is responsible for effective day-to-day coordination of all analytical activity. He is responsible for review and approval of all chemical analysis data generated for the task. The Chemical Analysis Supervisor's QA/QC responsibility is to ensure that QC requirements of the QA/QC Plan are implemented; to

provide guidance and technical support in resolution of QC problems; to support QA/QC preparation of control samples; and to provide guidance in preparation of analytical lots to ensure efficient, comprehensive analysis of all required parameters. This supervisor also provides additional authority, when needed, to support the QA/QC Coordinator in analytical matters and must approve all revisions of the QC Plan regarding analytical activities.

#### 2.1.6 ANALYST SUPERVISORS AND FIELD TEAM LEADERS

Analyst Supervisors and Field Team Leaders are responsible for provision of accurate field or laboratory data produced by analysts and sampling personnel under their supervision. They are responsible for ensuring that all QC procedures are followed and documentation provided. The QA/QC role of the Supervisors and Team Leader is, therefore, to assist the QA/QC Coordinator in enforcing QA/QC procedures.

#### 2.1.7 ANALYSTS AND SAMPLING PERSONNEL

It is the responsibility of the analysts and field team members to perform the required QA/QC procedures and to document all observations and calculations in the proper notebooks or standard forms. It is the responsibility of the analyst to perform preliminary QC checks including plotting QC charts to ensure that each batch of data being generated meets all analytical criteria specified in the QA Plan. The field team member or analyst must also bring any unusual observation or analytical problem to the immediate attention of his/her Supervisor or the QA/QC Coordinator. The analyst or field team member must ensure that all instruments are calibrated and the calibration recorded in permanent records. Each analyst is also responsible for ensuring that sufficient quantities of reagents of adequate quality are available for the performance of the required analyses.

### 3.0 ANALYTICAL SYSTEMS CONTROLS

#### 3.1 SAMPLE MANAGEMENT

A critical step in the processing of samples involves the initial check-in and preparation for analysis. Proper chain-of-custody, efficient processing to meet holding times, and avoidance of cross-contamination are vital to the integrity of the final data.

Samples are received by the Chemical Analysis Supervisor. They are unpacked and the logsheets compared with the contents. Samples are scheduled for processing, and the log sheets are given to the Data Management Coordinator, who activates the sample numbers for analysis. If any sample processing is required, it will take place immediately.

Sample log-in at the laboratory will be monitored by the QA/QC Coordinator. The QA/QC Coordinator will periodically check the computer logsheet for verification of complete conformance of the log to the sample set and verification of the information contained on the sample labels. Any inconsistencies or unusual circumstances, such as broken or leaking containers, improper preservation, or noncompliance with holding or shipping requirements will be identified in writing to the Project Manager and the Field Team Leader and the Project QA Supervisor. Corrective action will be recommended and approved by the Task Manager and the Project QA Supervisor.

Establishment of Army lots will be performed under the direction of the QA/QC Coordinator after the samples have been logged into the laboratory sample management system. The samples will be placed into analytical lots based on analysis and sample matrix type. The number of samples per lot will depend on the number of samples which can be conveniently and efficiently analyzed in one 24-hour day. The sample digestion/extraction or instrumental step may be the rate-limiting step. Other factors which should be taken into consideration in establishing lot

size include: (1) the type of analysis; (2) the analysis complexity; (3) the holding time for the sample; and (4) the time constraints imposed by well development, sampling, and shipping considerations. The batch lot will be optimized to provide efficient analysis while meeting the holding time criteria for the samples.

Every attempt will be made to maximize the number of samples per lot within the constraints of the daily rate-limiting step. Small lot sizes may be necessary due to the limited number of samples being collected at any particular installation, especially complex sample analysis or extraction procedures, or holding time constraints.

The following QA procedures will be implemented to monitor sample management and handling:

- The Project QA Supervisor or his representative will make a trip to each site to inspect the sampling. The QA Supervisor will audit the sampling procedures and ensure that procedures described in the scope of work are followed.
- The QA Supervisor will ensure that samples are being labeled, preserved, stored, and transported according to the prescribed methods.
- If the QA Supervisor determines that significant deviations from the sampling protocol have occurred, resulting in a compromise of the sample integrity, all samples taken prior to the inspection, subsequent to any previous inspection, will be discarded and fresh samples taken.
- The QA Supervisor will monitor the introduction of control samples (spikes and blanks) into the sample flow.

### 3.2 SAMPLING

This section describes the QC procedures to be followed during environmental matrix sampling. To ensure samples representative of the system under study, samples must be collected in properly cleaned containers, promptly and properly preserved, and transported to the

laboratory in a manner which minimizes the chance for significant change in constituents. The type of sample (grab, composite, etc.) and the location rationale of the sample point are described in the task Technical Plan. Proven sampling, preservation, and shipping methods which comply with USATHAMA and U.S. Environmental Protection Agency (EPA) specifications will be used to the extent possible. USATHAMA specifications will take precedence over any other specifications. The Field Team Leader is responsible for proper sample collection, documentation, preservation, and shipment. The QA/QC Coordinator monitors the receipt of samples, audits the field sampling procedures, and monitors compliance with preservation and holding time specifications.

At least one site visit will be performed by the QA Supervisor or his representative during each sampling effort to audit sampling performance. The QA Supervisor may require new samples to be collected if the sample collection procedures are unsatisfactory. Fig. 3.2-1 shows an example of the Field Sampling Audit Checklist, which should be filled out by the QA Supervisor during the site visit.

Pre-printed field notebooks will be made available to sampling personnel. Notebook pages will describe all the information that is required and the format that is consistent with entry into the IR-DMS. Many qualitative observations (e.g., sketches) that cannot be entered into IR-DMS and that must be used for preparation of later project reports should be retained in permanent record.

Field notebooks will be reviewed and signed by the appropriate Field Team Leader on a daily basis and reviewed by the QA Supervisor at the end of the sampling effort to ensure that each page is accurate, understandable, and complete. A copy of the computerized sample logsheet will accompany the samples as a part of the chain-of-custody record (Fig. 3.2-2).

Project \_\_\_\_\_ Project Number \_\_\_\_\_  
Date \_\_\_\_\_ Auditor \_\_\_\_\_  
Project Location \_\_\_\_\_ Title of Auditor \_\_\_\_\_

Item	Yes/No	Comment
1. Does each member of the field team clearly understand his/her role and position in both the project and field team structure?		
2. Has a Field Sampling Plan been filed in the proper manner?		
3. Does each team have in its possession a copy of the Sampling and Analysis Plan of the QA Plan?		
4. Is a permanent field notebook being kept?		
5. Does the notebook contain all required information?		
6. Has the Field Team Leader signed all pages in the notebook at the end of each day?		
7. Has all field instrument calibration information been placed in the notebook?		
8. Are samples taken from representative locations?		

Figure 3.2-1  
FIELD SAMPLING AUDIT  
CHECKLIST  
(Page 1 of 3)

Prepared for:  
U.S. Army Toxic and Hazardous  
Materials Agency  
Aberdeen Proving Ground, Maryland

Item	Yes/No	Comment
9. Does the field team have a copy of detailed calibration and operation instructions for every instrument?		
10. Are instruments properly calibrated at least daily?		
11. Are replicate samples taken at 10 percent of the sample sites?		
12. Are samples preserved in the proper manner?		
13. Are sample containers appropriate for the parameters to be studied?		
14. Are preservative acids and reagents of known, high purity and appropriate for the analysis?		
15. Are samples shipped so that they arrive at the laboratory within holding times?		
16. Are labels with all required information affixed to each sample container?		
17. Has back-up identification of each sample container been made?		
18. Are proper preservation codes used on the sample labels?		



Item	Yes/No	Comment
19. Has a standard shipping form been included in <u>each</u> package?		
20. Are samples properly logged in on arrival at the lab?		
21. Are the samples collected in a safe and legal manner?		
22. Were field instrumentation and supplies properly requested?		
23. Have a Receiving Clerk and alternates been appointed?		

Source: Environmental Science and Engineering, Inc., 1980.

ENVIRONMENTAL SCIENCE & ENGINEERING 011/15/84 \*\*\* FIELD LOGSHEET \*\*\* STORET MAP # 28.9 RMAOC DD:  
PROJECT NUMBER: 84631600 PROJECT NAME: RMA OFFPOST CONTAM. ASSESSMENT LAB COMD. P.C.GEISZLER

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	AN.	SUBSET
29300	2		UF DF C N N				
29301			UF DF C N N				
29302			UF DF C N N				
29303			UF DF C N N				

NOTE -CHANGE OR ENTER SITE ID'S AS NECESSARY UP TO 6 ALPHANUMERIC CHARACTERS MAY BE USED  
-CIRCLE FRACTIONS COLLECTED. ENTER DATE, TIME, FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES  
-HAZARD CODES: I=IGNITABLE C=CORROSIVE R=REACTIVE T=TOXIC WASTE N=OTHER ACUTE HAZARD! IDENTIFY SPECIFICS IF KNOWN  
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME) RECEIVED BY: (NAME/ORGANIZATION/DATE/TIME)  
1  
2  
3

OTHER FIELD NOTES:

SOURCE: ESE, 1983.

Figure 3.2-2  
TYPICAL LOG SHEET AND FIELD  
CHAIN OF CUSTODY RECORD  
(Reduced)

Prepared for:  
U.S. Army Toxic and Hazardous  
Materials Agency  
Aberdeen Proving Ground, Maryland

The following QC practices (consistent with the USATHAMA QA Program) will be used during field sampling

### 3.2.1 VOLATILES

Loss of volatile compounds from water samples can occur through evaporation. Care should be taken to preclude aeration of the sample with any gas, to fill bottles completely with the samples allowing no air space, and to analyze within the specified holding times.

Volatile compounds may be analyzed in soil samples only if a solvent extraction step such as tetraglyme extraction is used in the analysis.

### 3.2.2 GROUND WATER

Ground water sampling should not be performed until after newly installed monitor wells have been allowed to reach equilibrium (no less than 14 days after well development). All observations and pertinent data developed during ground water sampling will be recorded in a field notebook similar to the field notebook used for surface water sampling (see Sec. 3.2.3). The following procedures will be followed on each sampling day.

1. The depth to water will be measured and recorded in the field notebook.
2. Samples will be taken after the fluid in the screen, well casing, and annulus has been exchanged five times. The amount of fluid exchanged will be measured and recorded in the field notebook. All sampling will be accomplished by a dedicated bailer constructed of polyvinyl chloride (PVC). No glue will be used in the construction of these bailers. A sample of the PVC used for construction of the bailers will be retained for possible future chemical analysis.
3. To protect the wells from contamination during sampling procedures, the following guidelines will be followed.
  - a. A separate bailer will be supplied for, and attached to, each well. This bailer will remain in place in the well during the monitoring phases.

- b. When a pump is used to purge the standing water from the well, the pump and associated hoses will be thoroughly cleaned between the samples using water from an approved source.
  - c. All sampling equipment will be placed on disposable polyethylene plastic sheeting spread on the ground at the well to prevent soil contamination from tainting the ground water samples. Each polyethylene sheet is to be used at only one well and then discarded to avoid cross-contamination. A sample of polyethylene sheeting will be retained for possible future chemical analysis.
- 4. The sample will be collected in a manner which will minimize its aeration and prevent oxidation of reduced compounds in the sample. The container will be filled to overflowing without air bubbles and tightly capped.
  - 5. Samples for metal analyses will be vacuum filtered in the field through a 0.45-micron (u) nitrocellulose filter, chilled to 4 degrees Celsius (°C), appropriately preserved, and immediately transported to the laboratory.
  - 6. Each sample bottle and cap will be rinsed with water from the well at the time of sampling.
  - 7. Onsite measurements of water quality will include conductivity, pH, and temperature. Calibration standards will be run prior to each set of measurements. Calibration standards for conductivity shall consist of solutions of potassium chloride having conductivities of approximately 1400, 700, and 150 umhos/cm. pH buffer solutions at pH 7.0, 10.0, and 4.0 are used to calibrate pH meters.

### 3.2.3 SURFACE WATER

Prior to surface water sampling, the following data will be noted and recorded in the field notebook:

- 1. Site number or location;
- 2. Date;

3. Time (24-hour system);
4. Antecedent weather conditions, if known;
5. In situ parameter measurements;
6. Fractions and preservatives;
7. Any other pertinent observations (odor, fish, etc.); and
8. Signature of sampler and date.

At the conclusion of each day in the field, the Field Team Leader will review each page of the notebook for errors and omissions. He/she will then date and sign each reviewed page.

All field instrument calibrations will be recorded in a designated portion of the notebook at the time of the calibration. Adverse trends in instrument calibration behavior will be corrected.

A single mid-current sampling point will be used for most streams where lateral mixing is complete. Sampling will take place at approximately 1/2 to 2/3 of the water depth at its deepest point.

Sampling the edge of a stream from the bank will be avoided if possible. If unavoidable, sampling will be on the outside of a bend where the current flows along the bank. This will avoid collection of quiet or even stagnant water of a quality that does not represent that of the main flow. Care will be taken to sample at a point on the stream with complete vertical and lateral mixing. Samples will not be taken immediately below a waste source or tributary, unless there is a specific reason to do so.

Sampling in shallow lakes with good vertical mixing (as indicated by in situ measurements) will be accomplished with surface grab samples. Care will be taken that oil or gasoline leakage from the boat motor, if used, does not affect the water being sampled.

In rivers, streams, and very shallow lakes, fractions will be taken as a grab sample. The sample container will be held just beneath the surface of the water and allowed to fill.

Prior to the sample collection, each sample bottle will be rinsed with the stream water immediately downstream from the sampling point. Surface water samples will not be filtered prior to analysis.

#### 3.2.4 SOIL

The procedures described below are general procedures to be followed in the absence of specific sampling protocols in the Technical Plan. The Technical Plan specifies a particular sampling protocol using polybutyrate sampling tubes. Sections of these tubes will be capped and sent to the laboratory for analysis in wide-mouth glass jars.

Appropriate point sampling or compositing techniques, as defined in the Technical Plan, will be used to ensure that the sample is representative of the area sampled and the type of information (e.g., depth of contamination) desired. Soil samples will be placed in an amber or foil-wrapped glass wide-mouth jar with Teflon®-lined lid.

Sample containers will be labeled with a preprinted label, chilled to 4°C, and shipped to the laboratory for analysis. No plastic should be allowed to contact soil samples requiring organic analysis.

#### 3.2.5 SEDIMENTS

All sediment samples will be collected with a hand piston sampler or other appropriate device. After sampling, depth of water at each sampling point will be measured and recorded. Sampling equipment will be thoroughly cleaned with water from an approved source and solvent rinsed with acetone and hexane and allowed to air dry.

Sediment samples will be placed in amber glass or foil-wrapped containers with Teflon®-lined lids, shipped under ice, and stored at 4°C.

Observations recorded in the field notebook at time of soil sampling will consist of:

1. Site identification;
2. Description of location, including distance from surveyor's stake to sample point;
3. Date;
4. Time (24-hour system);
5. Description of vegetation;
6. Characteristics of soil;
7. Sample number;
8. Fractions and preservations;
9. Other observations; and
10. Signature of sampler.

### 3.3 SAMPLE PRESERVATION

The Field Team Leader is responsible for proper sampling, labeling of samples, preservation, and shipment of samples to the laboratory in a proper manner to meet required holding times. Table 3.3-1 identifies the preservation methods and holding times that will be used for the RMA analytes. Amber-glass bottles or bottles wrapped to prevent light exposure will be used for all samples to be analyzed for organic species. Plastic containers will be constructed from linear polyethylene. The holding times in Table 3.3-1 apply to both water and soil/sediment samples.

Table 3.3-2 identifies the sampling container and the proper preparation of sampling containers to ensure that all samples properly represent constituents within the environmental matrix sampled. Responsibility for properly prepared sampling containers and preservation reagents rests with the ESE Chemical Analysis Supervisor, based on the notification of the sampling schedule by the Field Team Leader and/or ESE Task Manager.

Table 3.3-1. Preservation Methods and Holding Times

Analysis/Analyte	Preservation Method		Maximum Holding Times	
	Soils	Water	Soil	Water
<u>Volatile Organics</u> (methanol extraction for soils) GC, GC/MS	Cool, 4°C	Cool, 4°C 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> *	7 days (extraction) 30 days (analysis)	14 days
<u>Extractable Organics</u> GS, GC/MS, HPLC	Cool, 4°C	Cool, 4°C 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> *	7 days (extraction) 30 days (analysis)	7 days (extraction) 30 days (analysis)
<u>Metals</u>				
Mercury (AAS cold vapor)	Cool, 4°C	Cool, 4°C HNO <sub>3</sub> to pH <2†	28 days	28 days
Other Metals (ICAP)	Cool, 4°C	Cool, 4°C HNO <sub>3</sub> to pH <2†	6 months	6 months
<u>Anions</u>				
Sulfate	Cool, 4°C	Cool, 4°C	28 days	28 days
Nitrate	Cool, 4°C	Cool, 4°C	48 hours	48 hours
Chloride	Cool, 4°C	Cool, 4°C	28 days	28 days
Phosphate	Cool, 4°C	Cool, 4°C	48 hours	48 hours
Fluoride	Cool, 4°C	Cool, 4°C	28 days	28 days

\*Used only in presence of residual chlorine.

†Filter onsite before adding preservative.

Source: ESE, 1985.



Table 3.3-2. Sample Containers and Cleaning Procedures

Analysis/ Parameter	Container Type	Matrix	Cleaning Procedure*
GC/MS Analyses Organic Compounds	Amber-Glass Bottle with Teflon®-Lined Cap	Water	1
	Glass Mason Jar-- Foil-Wrapped or Amber with Teflon®- Lined Cap	Soil/Sediment	1
Volatile Organics	Amber Septum Vial with Teflon®-Lined Septum	Water and Soil	2
GC/HPLC Analyses Organic Compounds	Amber Glass Bottle with Teflon®-Lined Cap	Water	1
	Glass Mason Jar-- Foil-Wrapped or Amber with Teflon®- Lined Cap	Soil/Sediment	1
Metals	Linear Polyethylene Cubitainer	Water	3
	Glass Mason Jar with Teflon®-Lined Cap	Soil/Sediment	1
Anions: Cyanide, Nitrates, Sulfate, Phosphate, Fluoride, Chloride, Other Inorganics	Linear Polyethylene Cubitainer	Water	4
	Glass Mason Jar with Teflon®-Lined Cap	Soil/Sediment	1

- \* 1--Thoroughly wash container with hot detergent and water; triple rinse with tap water; triple rinse with D.I. water; rinse with (nanograde) acetone; rinse with (nanograde) hexane; bake at 200°C for 2 hours, except 1-gal amber jugs, always use new jugs and air dry.
- 2--Thoroughly wash container with hot detergent and water; triple rinse with tap water; triple rinse with D.I. water; air-dry; bake at 200°C for 2 hours; soak septa for several hours in methanol; bake at 150°C for at least 1 hour. (Note: Always use new bottles, do not reuse bottles).
- 3--Rinse with 2 to 3 ml of ultrex nitric acid and drain thoroughly.
- 4--No cleaning procedure required; use new cubitainer. This is a deviation from USATHAMA QA Plan.

Abbreviations

GC/HPLC = Gas chromatography/high-pressure liquid chromatography.  
D.I. = Deionized.

Source: ESE, 1985.

### 3.4 SAMPLE PREPARATION

The following paragraphs describe the preparation of water, soil, sediment, and standard samples for analysis. The QA/QC Coordinator will monitor the sample preparation procedure to assure compliance with USATHAMA requirements.

#### 3.4.1 WATER SAMPLES

Only ground water samples for metals analyses will be filtered prior to analysis. Ground water samples for other analytes and surface water samples will not be filtered. This practice is a deviation from the USATHAMA QA Plan.

#### 3.4.2 SOIL SAMPLES

Percent moisture for soils and sediments will be determined prior to analysis using a procedure comparable to American Society for Testing and Materials (ASTM) Method D2216-71 (ASTM, 1981) on as-received soils and sediments.

Soils for the RMA survey will not be dried and sieved before analysis. This is a deviation from the USATHAMA QA Plan.

#### 3.4.3 SEDIMENT SAMPLES

Because of the long drying times involved in processing and sieving very wet sediments, sediments will be analyzed in their "wet" condition. The sediment sample will be made as homogeneous as possible by vigorous mixing with a spatula before a subsample is taken.

#### 3.4.4 STANDARD SAMPLES

Preparation of standard soil and water for methods development and analytical systems control is described in Sec. 3.8.2. Standard soil consists of uncontaminated soil similar to that found at RMA.

### 3.5 SUBSAMPLING

Subsampling the field soil sample to size will be performed by the analyst upon arrival of the sample at the ESE laboratory. All subsampling will be accomplished using coring techniques described in the Technical Plan.

### 3.6 CONTROL SAMPLES

Control samples will be analyzed with actual field samples as a monitor on the performance of the analytical system. Control samples will consist of spiked standard samples and blanks for all analyses except GC/MS. In GC/MS analyses, natural samples as well as standard matrix samples are spiked as control samples. Results from spiked standard matrix control samples will be used to construct control charts to monitor variations in the precision and accuracy of routine analyses. The specific type and number of control samples and the construction of control charts are described in Sec. 4.2.

### 3.7 REFERENCE MATERIALS

When available, SARMs supplied by USATHAMA must be used to prepare calibration standards and spiking standards. SARMs or interim SARMs are materials that have undergone extensive purity and stability checks. When SARMs are not available or their quantities limited, "as is" chemicals may be used as interim reference materials. However, the "as is" material should be stored at 0°C and a portion retained for a comparison with the approved SARMs when available.

All reference compounds used in the USATHAMA projects will be stored at 0°C and protected from light. The QA/QC Coordinator will request SARMs as required. The QA/QC Coordinator maintains a record of receipt of SARMs and monitors their use.

### 3.8 ANALYTICAL METHODS AND CERTIFICATION

#### 3.8.1 RATIONALE

Two different types of analyses recognized by the USATHAMA QA program (semiquantitative and quantitative analysis) may be conducted. Each type of analysis requires a different level of documentation, including precision and accuracy data and a different set of daily or batch-related QC criteria. The following sections outline the testing procedures which will be used to define the detection limit, precision, and accuracy of each analytical method.

Method certification in standard media will certify the laboratory to run semiquantitative or quantitative analyses for a given analyte. Documentation of the analytical testing certification will be submitted to USATHAMA for approval before use of the analytical method for analysis.

#### 3.8.2 METHOD CERTIFICATION

The following paragraphs describe the procedures to be used to certify analytical methods. All methods certification and documentation data will be developed in standard matrices.

The standard matrix for documentation of inorganic analyses (e.g., sulfate, nitrate, or metals) in water will be deionized water conforming to ASTM Type II grade water. The standard matrix for documentation of organic analysis will be deionized, organic-free (ASTM Type IV) water containing 100 milligrams per liter (mg/l) each of sulfate and chloride prepared as follows:

1. Add 1.48 grams (g) of dried analytical reagent-grade anhydrous sodium sulfate to a 1-liter (l) volumetric flask and dilute to volume.
2. Add 1.65 g of dried analytical reagent-grade sodium chloride to a 1-l volumetric flask and dilute to volume.
3. Transfer 100 ml of each (1 and 2) to a 1-l flask and dilute to volume.

The resulting solution is 100 mg/l each of chloride and sulfate ions. These two types of water will be used as blanks or will be spiked with the compound(s) of interest prior to processing through the complete analytical protocol.

The data for documentation of both inorganic and organic analyses in soils and aquatic sediments will be developed using an uncontaminated "standard" soil matrix. An aliquot of "standard" soil will be carried through each set of documentation samples to act as a blank. Added concentrations of the subject analyte(s) will be dissolved in a volume of solvent just sufficient to wet the soil. This solution is poured over the subsample of soil and allowed to stand for 1 hour prior to beginning analysis, and the solvent is allowed to evaporate.

The "standard" soil will consist of a homogeneous sample of sufficient size to provide a single continuous source for all method documentation and subsequent analytical system control. The "standard" soil will be selected to conform with the type of soil to be encountered at RMA.

If, and only if, a column is to be used for the extraction, the analyte may be dissolved in the minimum quantity of the solvent consistent with volumetric transfer. The solution is placed on the column and allowed to soak in before additional extracting solvent is introduced.

Certain compounds or elements (e.g., nitrate or iron) will be present as a natural component of the soil. This background will be accounted for where it exists, and the detection limit for the particular method will be considered as the statistically resolvable quantity above the background concentration.

#### Semiquantitative Analyses

Semiquantitative analytical methods are used in USATHAMA programs to screen samples for the presence of unknown, as well as known, contaminants.

The detection limit of the total method will be estimated by spiking standard matrices of interest (water, soil, etc.) with the specific analytes or surrogate analytes with the widest range possible to remain within the linear range of the instrument in the following sequence: 0 (blank), 0.5X, X, 2X, 5X, 10X, 20X, 50X, 100X, and 200X, where X is the desired or required detection limit. The analyte should be dissolved in a water-miscible solvent to prepare the spiking solution. The spiked levels should be as close as possible to those listed, but a reasonable attempt at producing these levels will be considered acceptable. The spiked samples will be analyzed through the entire analytical method without dilution for analysis. After analysis, the detection limit will be calculated using the USATHAMA detection limit program. The detection limit determined by this process will be reported as the detection limit of the semiquantitative method.

In summary, certification of a semiquantitative method requires the following:

1. One spiked standard matrix sample at each of five concentration levels, plus a blank analyzed in a single day.
2. The detection limit calculated using the USATHAMA detection limit program.
3. The precision of semiquantitative analyses will be reported as "999." on data management entries.
4. The accuracy will be the slope of the best-fit linear regression line of found versus target concentration.
5. The best-fit linear regression line must have a minimum correlation coefficient of 0.996 for the calculation of the detection limit and accuracy. Exceptions to this criterion must be approved by the USATHAMA Analytical Branch.
6. Documentation of the procedures in USATHAMA format.

Semiquantitative certification for the GC/MS analysis will be performed using a mixture of actual analytes and surrogate standards approved by USATHAMA and specified in the Technical Plan.

### Quantitative Analyses

Requirements for certification of a quantitative method are as follows:

1. One spiked standard sample at each of five concentration levels, plus a blank analyzed each day for 4 separate days.
2. The detection limit will be calculated using the USATHAMA detection limit program.
3. The precision of the quantitative analyses will be the standard error of the best-fit linear regression line of found-versus-target concentration values for the data generated during the certification testing.
4. The accuracy of the quantitative analyses will be the slope of the best-fit linear regression line of found-versus-target concentration.
5. Documentation of the procedures in USATHAMA format.

### 3.9 ANALYST CERTIFICATION

A list of qualified analysts for each analytical method will be maintained by the QA/QC Coordinator. At regular intervals, the Analyst Supervisors will review the capabilities of each analyst and recommend whether certification should be continued.

During the conduct of this project, the QA/QC Coordinator will inspect the laboratory periodically to determine if analyses are being performed only by certified analysts. Data reports require the name of the analyst on the report sheet. All sample lots will be checked to verify that certified analysts performed the analyses.

Analysts will demonstrate their proficiency in conducting a particular chemical analysis by showing evidence of acceptable performance on past routine QC samples analyzed with each batch of samples.

In addition, for any analytical method, analysts or an analytical team consisting of specific individuals will be considered to be certified to run a particular analysis, if they have been involved in developing the

precision and accuracy data needed for method documentation. The precision and accuracy data generated during method documentation must be acceptable to the Chemical Analysis Supervisor and the QA/QC Coordinator. New analysts performing an established analytical procedure will be considered to be conditionally certified until the first set of QA/QC data are generated. These QC data are required for every lot of samples analyzed. If these QC data are in control based on precision and accuracy control charts, the analyst or analytical team will be considered to be certified to run that particular analysis. QC data which do not meet established QC requirements will be rejected, and corrective action which may include reanalysis of the lot of samples and further training of the analytical team, will be taken.



#### 4.0 ANALYSIS OF SAMPLES

The following describes the QC procedures and requirements for sample analyses conducted during this project. These QC requirements are in addition to any specific calibration requirements presented in Sec. 5.0. All samples will be analyzed within the certified range of the analytical method. Dilution of a sample extract with extracting solvent or of the original sample matrix with distilled/deionized water should be performed if the concentration of analyte is greater than the certified range of the method.

##### 4.1 LABORATORY INSTRUMENT QC CONTROLS

Daily QC of the analytical systems ensures that accurate and reproducible results are produced. The analyst must check instrumental calibration data for compliance with QC requirements. Unless specified differently in the approved USATHAMA methods, Table 4.1-1 describes the general instrumental QC checks to be implemented for the RMA survey project.

Initial calibration should be performed under the following conditions: (1) when an analysis is first set-up or prior to the first set of samples, (2) when the instrument has been idle for long periods of time, (3) when the instrument detector has been subject to major maintenance, or (4) when the instrument fails the daily calibration QC checks.

Deviations from the USATHAMA instrumental QC requirements will occur for certain analyses. The requirement for recalibration of the instrumental system at the end of each day's run is not practical or necessary for certain analyses using standard EPA procedures because of the excessive time required for calibration. For most analyses (cyanide, phenols, GC, HPLC, nutrients, etc.), only one calibration standard will be repeated

Table 4.1-1. Summary of Instrumental Systems Control Requirements

Requirement	Analytical Control Limits
<ul style="list-style-type: none"> <li>Initial Calibration (using actual analytes or surrogates) (GC/MS uses surrogates and actual analytes)</li> <li>Daily Calibration (except GC/MS)</li> <li>Daily GC/MS Calibration</li> </ul>	<ul style="list-style-type: none"> <li>Calibration curve--concentration series 0 (blank), 0.5X, X, 2X, 5X, and 10X, where X is the concentration of analyte in the instrumental standard corresponding to an analyte concentration in the sample at the desired detection limit</li> <li>Calibration curve--concentration series 0 (blank), X, 5X, and 10X minimum</li> <li>All samples analyzed must be bracketed by standards above and below and be within the established certified range of the method</li> <li>Calibration standard is repeated at end of day or analytical run, and response of the standard must agree with previous response within <u>+15%</u></li> <li>Correlation coefficient of standard curve <u>&gt;0.995</u></li> <li>One calibration standard is run and calculated response factor for surrogate analytes must agree with initial calibration response factors within <u>+25%</u> or new calibration curve run</li> <li>All samples analyzed must be within the linear range of the instrument and the certified range of the method</li> <li>Instrument calibration with DFTPP or BFB</li> </ul>

ICAP = Inductively coupled argon plasma.  
DFTPP = Decafluorotriphenylphosphine.  
BFB = Bromofluorobenzene.

Source: ESE, 1983.

at the end of the day. [All samples will be bracketed by calibration standards.]

#### 4.2 CONTROL SAMPLES

Control samples are spiked samples of standard water or "standard" soil which are run with each lot of samples. Table 4.2-1 summarizes the control samples and control charts required for the USATHAMA projects.

In applying the QC requirements presented in Table 4.2-1 to quantitative analyses and parameters, at least three control samples will be run with each daily lot of samples. In applying the QC requirements presented in Table 4.2-1 to some analyses and parameters, modifications to these requirements may be necessary. For certain GC, high-pressure liquid chromatography (HPLC), and GC/MS analyses, the daily through put of samples is severely limited by the instrument analysis runtime. In these cases, ESE may define the number of samples which can be analyzed over a 3-day period as one lot and apply the control spike requirements to this 3-day lot. At least one control spike extract will be analyzed on each day of instrument analysis. USATHAMA approval of this deviation will be required prior to sample analysis.

Since certification for semiquantitative analyses only requires that one target-versus-found curve be established, the designation of control limits for accuracy based upon the standard deviation of the slopes of a number of target-versus-found curves is not possible. In this case, ESE will use historical data from previous analyses (if any) or will set up temporary control limits on the slope of the control sample curves of +20 percent. After four lots have been analyzed, criteria based on +3S (S = standard deviation of slope) will be established.

The QA/QC Coordinator is responsible for the introduction of the control samples into each analytical lot before analysis. Subsequent to analysis, the QA/QC Coordinator reviews and approves all control sample data by Army lots before the results are transmitted to USATHAMA as

Table 4.2-1. QC Requirements by Sample Lot

Requirement	Analytical Control Limits
<ul style="list-style-type: none"> <li>Control Samples (Quantitative and Semi-quantitative Analyses) (Except GC/MS)</li> </ul>	<ul style="list-style-type: none"> <li>At least one standard matrix method blank for each daily lot.</li> <li>Three standard matrix control spikes at approximately 2X, 5X, and 10X, where X is the documented detection limit per daily lot.</li> </ul>
<ul style="list-style-type: none"> <li>Control Samples (GC/MS Semiquantitative Analyses)</li> </ul>	<ul style="list-style-type: none"> <li>At least one standard matrix method blank for each daily lot spiked with deuterated surrogate standards at the 5X level.</li> <li>Deuterated surrogate standards spiked at approximately 2X, 5X, and 10X, where X is the concentration in the matrix corresponding to the documented detection limit. The original matrix of each sample and method blank is spiked with one of the above levels. Lot must contain at least one sample spiked at the 2X, 5X, and 10X level.</li> </ul>
<ul style="list-style-type: none"> <li>Accuracy Control Charts (Quantitative and Semi-quantitative Analyses) (Except GC/MS)</li> </ul>	<ul style="list-style-type: none"> <li>Plot slope of regression line of found-versus-target concentrations of spikes.</li> <li>Control limits (+3S) and warning limits (+2S) will be initially based on the standard deviation of the slope of regression lines obtained during method certification. Control limits are updated based on results of spiked samples analyses performed with each lot of samples.</li> </ul>
<ul style="list-style-type: none"> <li>Precision Control Charts (Quantitative Analysis Only)</li> </ul>	<ul style="list-style-type: none"> <li>Plot mean found concentration for the 5X spike level during the method certification.</li> <li>Control limits (+3S) and warning limits (+2S) will be initially based on the standard deviation of 5X level during method certification. Limits are updated based on results of 5X spikes performed with each lot of samples.</li> </ul>

Table 4.2-1. QC Requirements by Sample Lot (Continued, Page 2 of 2)

Requirement	Analytical Control Limits
<ul style="list-style-type: none"><li>● Precision Control Charts (Semiquantitative GC/MS)</li></ul>	<ul style="list-style-type: none"><li>● Plot the found concentration for the (5X level) deuterated surrogate standards spiked into the standard matrix method blank for each lot.</li><li>● Control limits (<u>+3S</u>) and warning limits (<u>+2S</u>) will be initially based on the standard deviation of 5X level during certification. Limits are updated on results of 5X spikes into standard matrix method blank performed with each lot of samples.</li></ul>

Source: ESE, 1985.

Level 1 data. Precision, accuracy, and the detection limit for each analytical lot which passes QC criteria are automatically entered into the appropriate chemical analysis file for transmission to USATHAMA. The QC results for the QC control samples also are included in the format required by the Installation Restoration (IR) Data Management User's Guide (USATHAMA, 1984).

Failure to pass the instrumental calibration or control sample QC criteria represents an out-of-control situation and calls for corrective action as required by the USATHAMA QA Plan, which may require rerunning and/or resampling and rerunning the entire lot samples. Written notification of QC failure is provided to the ESE Project Manager and the Chemistry Supervisor.

## 5.0 INSTRUMENT CALIBRATION AND MAINTENANCE

A calibration procedure establishes the relationship between an accurately known calibration standard and the measurement of that standard by an instrument. Calibration refers to absolute physical or electronic calibration and is not to be confused with chemical standardization. Chemical standards are run each time an instrument is used, while instrument calibration is performed only at specified intervals.

Operating procedures must be available for all equipment and analytical instrumentation. Such procedures are generally provided by the manufacturer.

Records of instrument calibration procedures amenable to absolute physical and/or electronic calibration performed by the laboratory or by an outside laboratory on a contract basis will be maintained.

Contracts for calibration services should require the contractor to supply records on traceability of their calibration standards.

All equipment which can undergo absolute physical or electronic calibration should have affixed to it, in plain sight, a tag bearing the following information:

Description: \_\_\_\_\_  
Identification No.: \_\_\_\_\_  
Last Calibrated: \_\_\_\_\_  
Calibrated By: \_\_\_\_\_  
Calibration Expires: \_\_\_\_\_

Note: Use of this instrument beyond the calibration expiration date is prohibited.

When the equipment size or its intended use limits the application of labels, an identifying code should be applied.

Equipment past due for calibration should be removed from service either physically or, if this is impractical, impounded by tagging or other means.

#### 5.1 FIELD INSTRUMENT CALIBRATION

Instruments used to perform field measurements (e.g., pH, temperature, conductivity, water level) will be calibrated in accordance with procedures outlined in the appropriate operating manual. All equipment will be calibrated daily. Calibration checks will be performed after measurements are made at each sampling site. All calibration data and calibration checks will be entered into the field notebook. Failure of an instrument to maintain accurate calibration will be reported to the Field Team Leader, who must take immediate corrective action to ensure that accurate field data accompany any samples. The faulty instrument is tagged and cannot be used until repaired and recalibrated.

- In the event that field measurements must be made using instruments having questionable accuracy or calibration, the Field Team Leader must immediately identify the problem to the QA Supervisor. If recommended corrective action involves including suspected measurements in the sampling record, this must be approved in writing by the Task Manager, USATHAMA COR, and the USATHAMA Analytical Branch. Generally, if proper field measurements cannot be performed, alternative means will be employed to verify the field data, which will be discarded, or the system will be resampled when accurate field measurements can be performed. These corrective actions will be agreed upon by the QA Supervisor, Project Manager, USATHAMA COR, and USATHAMA Analytical Branch.



## 5.2 ANALYTICAL NOTEBOOKS AND INSTRUMENT LOGBOOKS

The ultimate repository for information concerning analyses performed in the laboratory is the analyst's personal laboratory notebook and the instrument logbooks.

Each analyst is required to have a personal notebook designated by a unique number. Responsibility for maintaining complete laboratory notes lies with each analyst. The QA/QC Coordinator may audit laboratory notebooks without notice.

Laboratory notebooks will not be taken from the laboratory without written permission of the Chemical Analysis Supervisor and the Task Manager. Every entry into the notebook should be dated and signed. Entries in the personal notebook will vary depending on the role of the individual in the laboratory and the type of work being performed. At a minimum, the personal notebook should contain:

1. A reference to or a description of the procedures used for sample work-up or analysis,
2. A summary of the samples extracted or analyzed,
3. Weighings and calculations of standard concentrations, and
4. Information on spiking procedures and observations and comments on the procedures or samples.

An instrument logbook will be maintained for certain analyses. Each time an instrument is used for sample analysis, the following information is entered:

1. Date of analysis;
2. Project name and number;
3. Number of samples analyzed, type of sample;
4. Time spent on analysis (start to finish);
5. Preventive maintenance performed, if any;
6. Time spent on preventive maintenance;
7. Instrument calibration performed, if any; and
8. Name of analyst.

Additional notes are made in the instrument logs when required. These notes are particularly important when abnormal instrument or analytical performance is observed. It is the analyst's responsibility to ensure that instrument logs are properly filled out and kept up to date. The QA Supervisor monitors and audits the status of instrument logbooks.

No samples are to be run on any instrument which fails calibration and not until it is clearly demonstrated that the instrument is back in control.

### 5.3 SPECIFIC ANALYTICAL SYSTEMS MAINTENANCE

#### 5.3.1 METALS SYSTEM CONTROL

##### QC for Atomic Absorption Analysis

The following routine QC procedures are required for flame and graphite furnace atomic absorption analysis (AAS):

1. Instrument calibration is checked using standard solutions. Instrument response is plotted (using a hand calculator) against concentration. The slope is compared to historical slope data to verify that the performance of the instrument is satisfactory. The control charts are kept in the instrument logbook, which also contains a record of routine maintenance and documentation relating to any downtime due to instrument malfunctions. If readings are excessively low, the analyst will check gas flows, burner or cell alignment, wave length, slit width, photomultiplier voltage, and lamp intensity for problems.
2. Blanks and spiked samples are analyzed with each batch of samples.
3. Strip chart recorder tracings for standard solutions, samples, spikes, and duplicates are all stamped for identification and filed in the instrument room.

#### QC for ICAP

Analyses run on the ICAP system will require specific instrument calibration and maintenance controls. Routine maintenance on the ICAP system by the manufacturer's representatives is performed on an annual basis. In addition, a quarterly service contract is maintained on the minicomputer.

Periodically, the analyst will dismantle, clean, and reassemble the torch and nebulizer to prevent serious sensitivity problems.

Calibration with selected standards will be performed daily to ensure that the instrument performance has not deteriorated. The failure to achieve standardization could require cleaning, including changing the tubing of the sample delivery system. Spare parts are available for the system components most likely to experience failure.

Blanks and spiked samples are analyzed with each batch of samples. Hard-copy outputs for standards, samples, and spikes are stamped for identification and filed in the instrument room.

#### 5.3.2 GC

GC septa will be replaced on a weekly basis or more frequently as needed when symptoms of septum deterioration are noted. Frequent injections will require replacement on a daily basis. When the supply of gas in the cylinders falls below 100 psi, carrier and detector gases will be changed to prevent contaminants from reaching the detector or columns. Molecular sieves and oxygen traps used in the gas lines will be replaced on a regular basis. GC detectors will be removed and cleaned at least periodically to remove accumulations, which can affect instrument performance.

Instrument calibration curves will be monitored and compared to historical performance criteria. Excessive noise, low response, and poor precision are indicators of a dirty detector and may cause more frequent detector cleaning. Spare columns, packing materials,

instrument cables, and PC boards will be available in case of breakage or malfunction to minimize instrument downtime.

### 5.3.3 GC/MS ANALYSIS

Daily instrument control will be practiced to ensure that the instrument is calibrated and in proper working condition. The GC/MS will be tuned daily with perfluorotributylamine or to calibrate the mass axis and to ensure proper relative abundances. The instrument performance will be monitored with a reference compound such as decalfluorotriphenylphosphine (DFTPP), bromofluorobenzene (BFB), and/or with a composite mixture of compounds representative of the samples being analyzed. An instrument tuning log will be maintained to identify any deterioration of instrument performance. The composite reference mixture will be particularly useful for monitoring the relative sensitivity of the mass spectrometry (MS) and the integrity of the chromatographic column. Failure to achieve calibration will require implementation of source cleaning procedures.

In addition, all routine analytical systems controls performed for GC will also be performed for the GC/MS equipment. The ionizing source will be periodically dismantled, thoroughly cleaned, and reassembled to prevent serious sensitivity problems.

## 6.0 DATA REPORTING

### 6.1 SEMIQUANTITATIVE ANALYSES

Results will be reported in terms of concentrations in the original matrix and will be corrected for recoveries and moisture. Results of samples which cannot be diluted into the certified range will be reported as greater than (GT) the upper limit of the certified range. Lack of indications of the presence of specific compounds to be reported will be reported as "less than" the certified detection limit.

Estimates of concentrations of species which have not been subjected to the method certification procedure and for which no standards are available, as in the GC/MS screening procedure, will be reported based on the response compared to the response of a reference compound or internal standard provided that: (1) the instrumental response of the species is at least 10 percent of the response of the internal standard compound; (2) the estimated concentration contains only one significant figure; (3) the estimated concentration is annotated as based on the reference compound; and (4) the estimated concentration is reported as the concentration in the original matrix assuming 100-percent recovery.

Results of the semiquantitative analyses will be entered into the Data Management System of USATHAMA, as outlined in the IR Data Management User's Guide (USATHAMA, 1981) with the following conditions:

1. Four characters (3 digits plus a decimal) to represent the slope of the least squares regression line of found-versus-target concentration values for control spike data in standard matrix samples obtained during method certification will be entered in the "Accuracy" columns.
2. For semiquantitative analyses in which estimates are based on a reference compound, the 3 digits for accuracy will be "000."
3. The precision of semiquantitative analysis will be reported as "999." on data management entries.

## 6.2 QUANTITATIVE ANALYSES

Estimates of concentration levels in quality control and actual samples will be reported to USATHAMA according to the guidance as outlined in the program tasking and the Data Management Users Guide. Reported values will be corrected for recoveries and moisture over the total analytical method to offer the best estimate of the actual concentration in the original matrix. Values less than the certified detection limit will be reported as "less than" the certified limit. Conversely, detection limits higher than the certified detection limit (as in the case of a sample with high background levels) will be reported as "less than" the higher detection limit.

The slope of the best-fit linear regression line of found-versus-target concentration values from control spike data in standard samples obtained from the method certification will be reported as the accuracy.

The standard error of the best-fit linear regression line of found-versus-target concentration values from control spike data in standard samples obtained during method certification will be reported as the precision of the measurements for that day.

The documented detection limit will be used to report data for the quantitative method.

## 7.0 DATA REVIEW AND VALIDATION

The QA/QC Coordinator is responsible for reviewing and approving all analytical data before transmittal of data to USATHAMA. Further, all data transmitted to USATHAMA must be validated by the QA/QC Coordinator or his representative. A subsample of the data is selected using the procedures specified in "Sampling and Procedures and Tables for Inspection by Attributes, Military Standard" (MIL-STD-105D, April 29, 1963). Validation involves a thorough review of the data documentation from reported results to raw data including recalculation of results on a selected subset of data. The QA/QC Coordinator in each respective laboratory will perform the validation process on that laboratory's data.

For the efficient flow of laboratory data to USATHAMA, it is critical that the QA and supervisory reviews of data be organized in a planned methodology which includes successful interface with the data management program. A formal review and sign-off sheet should accompany chemical analysis results of each completed lot of samples. The data are routed to several key individuals for approval. An example of this form is presented in Fig. 7.0-1.

**ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.**

**ARMY DATA REVIEW AND TRANSMITTAL FORM**

**ARMY LOT:** \_\_\_\_\_

**PROJECT NAME:** \_\_\_\_\_

**ESE BATCHES:** \_\_\_\_\_

**PROJECT NUMBER:** \_\_\_\_\_

	Date	Initials	Comments
1. Group Leader (Army Batch Complete-All ESE Batches Grouped in Army Batch)			
2. Data System Coordinator (MARSQC, ESE Report)			
3. Group Leader Review and Approval			
4. Chemical Supervisor Review and Approval			
5. Data System Coordinator (Corrected ESE Report/ MARSQC USATHAMA Report)			
6. Chemical Supervisor Approval			
7. QA Supervisor (ESE Report, USATHAMA Report, MARSQC)			
8. Data System Coordinator Review and File			
9. Transmittal to Army (WTC)			

**Note:** Data may be released to the ESE Project Manager as preliminary data subject to revision after the review of the QA Supervisor in Step 7.

**COMMENTS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

SOURCE: ESE, 1983.

**Figure 7.0-1**  
**ARMY DATA REVIEW FORM**  
(Reduced)

**Prepared for:**  
**U.S. Army Toxic and Hazardous**  
**Materials Agency**  
**Aberdeen Proving Ground, Maryland**



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- U.S. Environmental Protection Agency (EPA). 1979. Guidelines Establishing Test Procedures for the Analysis of Pollutants; Proposed Regulations; Correction. Federal Register 44(244):75050-75052.

**APPENDIX C**

**ESE'S REMOTE LABORATORY DATA MANAGEMENT  
STANDARD OPERATING PROCEDURES**

**Environmental Science and Engineering, Inc.**

**Remote Laboratory Data Management**

**Standard Operating Procedures**

**October 26, 1984**

**by: W. Thomas Gillespie**

## Introduction

The remote lab DATA program is designed to be a compatible subset of the DATA program described in ESE's Chemical Laboratory Analysis and Scheduling System. The software includes sample login, STORET update of parameter name and QC criteria, DATA batch setup, entry of calibration information, entry of QC sample data (replicates and spikes), entry of sample data, printout of QC and sample results, and transmission of data to ESE's CLASS data system using a telephone modem.

This manual is intended to instruct the analyst on setup and routine operation of the Compaq DATA program. Users should refer to the CLASS manual for information not contained in this manual.

## Program Initialization

To startup the program use the following procedure:

1. Check to see if all components are turned-off.
2. Check to see if printer is plugged in to wall outlet and parallel interface cable is connected to the Compaq.
3. Adjust printer to the top of page perforation using the black knob. Don't use this knob to adjust paper later as this will reset the top of page, push the on line button and use the line feed or form feed buttons instead. Be sure to put the printer back on line or the system will 'hang-up' when it tries to output to the printer.
4. Turn on the printer.

\*\*\*\*\*  
If using a dual floppy disk drive system:

5. Put the MS-DOS 2.02 floppy disk in Drive A with the label facing the screen side of the computer.

\*\*\*\*\*  
6. Turn on the computer and wait about a minute for the disk to bootup. If for some reason you lose power or turn the machine off you must wait 15 seconds to turn it back on. Failure to wait 15 seconds will result in the computer not starting up. If this happens turn the computer off, wait 15 seconds and try again.

\*\*\*\*\*  
If using a dual floppy disk drive system:

7. Remove the MS-DOS disk from drive A and insert the Revelation Master Disk. Insert the Revelation Data Disk in Drive B.

Else:

Enter "CD \REVE" .

8. Enter "REV" and press return.
9. Enter "SYSPROB" for account name.
10. The DATA system menu will appear on the screen.

If you type "end" at the DATA system menu prompt you will exit to the Revelation Operating System which will prompt you with a ":". To return to the DATA system type "DATA" and press return. To exit Revelation and return to MS-DOS enter "OFF" and press return at the ":" colon prompt.

The revelation operating system uses several conventions for

editing input screens. These include:

If at the "Change?" prompt:

"end"	quit record without updating
item number i.e. "2"	change the indicated item
"delete"	deletes the record being displayed
"?"	lists acceptable entry format
return	file screen with updates

If changing a multivalued field (i.e. concentrations and responses for a calibration curve:

"add"	add another multivalued item (i.e. conc, resp)
"d3"	delete the third item in multivalued field
"i2"	insert an item a position 3 in multivalued field
"3"	update the third item in the multivalued field

Please note that for the multivalued fields in the batch header file for storet numbers and the corresponding multivalued fields in the sample raw data records the insert and delete options have inhibited. To delete a storet from a data batch replace the storet with a 0 or a negative number and the results report will skip this storet.

## 1. Enter Storet Name and Quality Control Criteria

Choosing option 1 on the DATA menu will load the Storet update screen. Enter the Storet number, press return and then the method number. If the storet and method are in the system the current data will be displayed and a change prompt will be displayed. Enter the number appearing to the left of item you wish to change or press return to return to the Storet number prompt. If this is a new entry you will be prompted for each data item. Examples of each data item are as follows:

Name & Units of Parameter: COD, High Level (mg/l)  
# Significant Decimal Places: 0  
# Significant Figures: 3  
Detection Limit: 25  
Average Recovery: 100  
Recovery +/- Control Limit: 15  
Replicate % Deviation Limit: 20

## 2.0 Login Samples

Before samples can be included into a data batch they must be logged-in using option 2 of the DATA menu. The login screen will be loaded and you will be prompted for the unique ESE sample id number. If the sample number you enter has been previously logged-in, the current data will be displayed and you will be prompted to enter the item number to change. Enter the number to the left of the item you wish to change or press return to return to the sample number prompt. If this is a new entry you will be prompted as follows:

6 Character Sample ID:	TEST-1
Sample Collection Date:	8/29/84
Collection Time:	13:27

## Analysis Subset:

LIST-1

3.0 Setup Data Batch

Prior to entering calibration, QC and sample data an analytical batch must be setup. The unique ESE analytical batch number assigned by the sample control center should be used. Normally a block of numbers will be allocated to the remote lab. If the batch has been previously entered you will be prompted with the change prompt. Otherwise the following items will be prompted for the batch setup:

Analysis Date: 8/29/84  
Analyst Employee #: 407  
Analyst Name: Tom Gillespie  
Notes on Analysis: Page 204-A  
multivalue field  
EPA Storet #: 640  
Analytical Method: 0  
Calculation Technique "QUAD" or "COD" or "FINL"

4.0 Enter Calibration Data

Individual calibration curves are accessed by a combination of the batch #, storet #, method #, and sequence #. If the curve has already been entered the data for the curve will be displayed and the change? prompt displayed. If it is a new curve the following items will be prompted for the calibration curve:

Detection Limit in Curve Units: 25  
Date of Calibration Run: 8/29/84  
multivalue field:

Conc of Calibration Std.: 10

Response from Calibration Std.: 9.87

After a curve is entered or updated the results of the regression analysis will be displayed.

5.0 Enter Quality Control Data

Individual quality control samples are accessed by a combination of the batch #, sample #, and the sample type. The sample types for QC samples include:

"R1" and "R2" for replicate samples

"S1" and "S2" for an unspiked and spiked sample

Be sure to include both pairs of analysis for replicates and spikes in order to be able to calculate QC results.

If the QC sample has already been entered the data in that sample record will be displayed and the change prompt displayed. If the sample is a new one the following items will be prompted for each storet in the batch:

Response or Conc: 12.34  
Status: "NA" to skip storet or leave blank  
Dilution Multiplier: enter dilution factor or leave blank  
Curve: enter curve # or leave blank  
Target Conc.: leave blank except for type 'S2'

6.0 Enter Sample Data

The sample data entry is very similiar to the QC sample data entry except that the sample type need not be entered and the spike prompt is eliminated. Valid statuses that can be included are: '<' '>' 'NA' 'RE' 'A9' (for an alphanumeric result).

## 7.0 Calculation of Quality Control and Sample Results

This option will output the results of quality control samples and sample data reduction to the printer. Be sure the printer is turned on and on line or the computer will sit and wait for the printer to be turned on. Replicate analysis are listed followed by spike sample analysis and then the sample results. Replicate and spike sample results for each storet are compared to the quality control criteria in the storet file and a "Failed \*\*\*" message will appear if the QC sample was outside of the control limits.

If one sample from a pair of QC samples has not been enter a warning message will be printed so that the sample can be printed and the results rerun.

## 8.0 Transfer Data to ESE's Prime 750 Minicomputer

Option 8 on the main data menu selects the option for making a data transfer file to be sent to ESE's Prime Computer. The transfer subprogram has two options. The first will produce a data transfer file containing sample login information. The samples to be transmitted are selected automatically by selecting all samples that have been updated since the date specified by the user. The second option will produce a data transfer file containing all of the unprocessed data for each data batch number that is specified by the user.

Both options will ask the user to place a blank formatted disk in disk drive A: when they are ready to produce the data transfer file. If using a hard disk system you may leave this disk in drive A: , otherwise you should replace the master revelation disk with this disk when prompted to do so and replacing it with the Revelation Master Disk when the file has been written.

To transfer the file to ESE's Prime Computer the user must exit the Revelation sytem by:

1. Entering "end" for selection in the Data Menu.
2. Entering "off" from Revelation command level.

Make sure the modem is hooked up correctly. You should have the DOS prompt ">" appearing next to the cursor at this point. Enter "RNET" and press return. Follow the instructions with your modem for dialing the Prime. To obtain information on accessing the Prime Computer call ESE's Lab Data Coordinator for access codes and instructions specidic to the task being performed.



8:31:54am

REMOTE LAB DATA MANAGEMENT  
08:31:53 26 OCT 1984

- (1) UPDATE STORET NAME & QC CRITERIA
- (2) LOGIN SAMPLES
- (3) SETUP DATA BATCH
- (4) ENTER CALIBRATION DATA
- (5) ENTER QUALITY CONTROL DATA
- (6) ENTER SAMPLE DATA
- (7) SAMPLE & QC RESULTS
- (8) PRODUCE DATA TRANSFER FILE

Enter Selection ?

## UPDATE STORET FILE

8:34:43am

C	EPA STORET NUMBER	340
02	ESE ANALYTICAL METHOD #	0
03	NAME & UNITS OF PARAMETER	COD, HIGH LEVEL (MG/L)
04	# OF SIGNIFICANT DECIMAL PLACES	0
05	NUMBER OF SIGNIFICANT FIGURES	3
06	DETECTION LIMIT	25
07	AVERAGE RECOVERY	100
08	RECOVERY +/- CONTROL LIMIT	15
09	REPLICATE % DEVIATION LIMIT	20

CHANGE ?

LOGIN ESE SAMPLES

8:36:01am

01	ESE SAMPLE #	300000
	DATE LOGGED IN	26 OCT 84
02	STATION ID	TEST
03	COLLECTION DATE	10-10-84
04	COLLECTION TIME	15:00
05	ANALYSIS SUBSET	SUB-1

CHANGE ?

ENTRY OF DATA BATCH SETUP INFORMATION

8:37:01am

01	DATA BATCH NUMBER	20000	
02	ANALYSIS DATE	10-11-84	
03	ESE EMPLOYEE NUMBER	407	
04	ANALYST NAME	TOM	
05	ANALYSIS NOTES	TEST	
06	EPA STORET #	01> 340	02> 1045

07	METHOD #	0	0
----	----------	---	---

08	CALCULATE TECH	COD	QUAD
----	----------------	-----	------

C NGE ?

# CALIBRATION CURVE DATA ENTRY

8:38:16am

C	DATA BATCH NUMBER	20000		
02	EPA STORET NUMBER	1045		
03	ESE METHOD NUMBER	0	IRON (MG/L)	
04	CURVE SEQUENCE #	1		
05	CURVE DETECTION LIMIT	5		
06	CURVE RUN DATE	10-25-84		
07	STD CONC.	01> 0	02> 5	03> 10
		04> 25	05> 50	06> 100

08	RESPONSE	0	6	9
		26	51	99

CONC= .1597 + .947\*RESPONSE + .0006\*RESPONSE\*\*2  
CHANGE ?

## SAMPLE & QC DATA ENTRY      STORET POSITIONS

8:42:10am

01	BATCH	20000	
02	SAMPLE	300000	
03	TYPE	S2	
04	RESPONSE	01> 20	02> 30

05 STATUS

06 DILUTION      2

07 CURVE

08 SPIKE TARGET      10      10

CHANGE ?

COD, HIGH LEVEL (MG/L)

RESULTS FOR BATCH: 20000 ANALYST: TOM ANALYSIS DATE: 11 OCT 1984  
REPORT DATE: 08:55:17 26 OCT 1984

REPLICATE SAMPLE RESULTS

REPLICATE SAMPLE: 300000

STORET MTH NAME	REP. 1	REP. 2	DIFF.	CRITERIA
340 0 COD, HIGH LEVEL (MG/L)	2300	2204	95	475
1045 0 IRON (MG/L)	19.3	20.3	.9	8.9

SPIKE SAMPLE RESULTS

SPIKE SAMPLE: 300000

STORET MTH NAME	UNSPIKED	SPIKED	FOUND	TARGET	XRECV
FAILED ****					
340 0 COD, HIGH LEVEL (MG/	2300	3216	915	10	9158
1045 0 IRON (MG/L)	19.3	29.1	9.7	10.0	97.7

SAMPLE: 300000 TEST COLLECTION DATE: 10 OCT 1984 TIME: 03:00PM

340 0 COD, HIGH LEVEL (MG/L)	53
1045 0 IRON (MG/L)	49.0

SAMPLE: 300001 TEST-2 COLLECTION DATE: 10 OCT 1984 TIME: 03:00PM

340 0 COD, HIGH LEVEL (MG/L)	213
1045 0 IRON (MG/L)	59.1

**APPENDIX D**  
**NEW PROJECT SETUP (NPS) FORMS**

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Project No. \_\_\_\_\_

FIELD TRIP PLAN APPROVAL FORM

Project Name: \_\_\_\_\_

Field Trip Site: \_\_\_\_\_

Field Trip Responsibility (Subproj. or Proj. Mngr.) \_\_\_\_\_

Field Team Leader: \_\_\_\_\_

Laboratory Coordinator: \_\_\_\_\_

Field Team Members: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SCHEDULING INFORMATION:**

Field Trip Briefing Mtg \_\_\_\_\_ (Date) \_\_\_\_\_ (Time)

Departure ESE \_\_\_\_\_ (Date) \_\_\_\_\_ (Time)

Site Arrival \_\_\_\_\_ (Date) \_\_\_\_\_ (Time)

Site Departure \_\_\_\_\_ (Date) \_\_\_\_\_ (Time)

Arrive ESE \_\_\_\_\_ (Date) \_\_\_\_\_ (Time)

**PLANNING INFORMATION:**

The following information must be attached (check to indicate):

\_\_\_\_\_ Sampling and Shipping Schedule; Lab/Field Contacts Established

\_\_\_\_\_ Sampling Location Layout

\_\_\_\_\_ Samples to be Collected and Fraction

\_\_\_\_\_ List of all Parameters to be Measured On-Site

\_\_\_\_\_ List of Field Equipment Requested

**APPROVALS:**

Laboratory Coordinator \_\_\_\_\_ (Date) Proj. or Subproj. Manager \_\_\_\_\_ (Date)

Field Team Leader \_\_\_\_\_ (Date) QA Manager \_\_\_\_\_ (Date)

REMARKS: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

cc: Project Director / Project Manager

SAMPLING DATE	METHOD OF TRANSPORT	SAMPLE ARRIVAL TIME AND DATE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

PHONE NUMBERS AND LOCATIONS TO CONTACT FIELD TEAM:

PHONE #	LOCATION	TIME TO CALL
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

LIST OF ON-SITE PARAMETERS:

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

LIST OF FIELD EQUIPMENT REQUESTED:

_____	_____	_____
_____	_____	_____
_____	_____	_____

DATE SUBMITTED: \_\_\_\_\_

DATE NEEDED: \_\_\_\_\_

NEW PROJECT SETUP (NPS)

FILL IN ONLY IF THIS IS THE FIRST FIELD GROUP FOR THIS PROJECT NUMBER.

PROJECT #: \_\_\_\_\_ PROJECT NAME: \_\_\_\_\_

PROJECT SUPERVISOR: \_\_\_\_\_ PROJECT SUBTITLE: \_\_\_\_\_

GEOPHYSICAL DESCRIPTION: \_\_\_\_\_

PREFIELD SETUP (PFS)

PROJECT #: \_\_\_\_\_ # LOGSHEETS REQUESTED: \_\_\_\_\_

FIELD GROUP NAME (<=5 CHARACTERS): \_\_\_\_\_

STORET MAP NUMBER (IF APPLICABLE): \_\_\_\_\_

DUE DATE MM/DD/YY (I.E. 2/14/85): \_\_\_\_\_ \*

LAB COORDINATOR: \_\_\_\_\_

\*NOTE - DUE DATE REQUIRED BY TIME OF LOGSHEET SUBMISSION.

NUMBER STATIONS REQUIRING LABELS (MAXIMUM # = 100): \_\_\_\_\_

SITE/STATION IDENTIFICATION CODES IF KNOWN (<=6 CHARACTERS)

1. _____	11. _____	21. _____	31. _____
2. _____	12. _____	22. _____	23. _____
3. _____	13. _____	23. _____	33. _____
4. _____	14. _____	24. _____	34. _____
5. _____	15. _____	25. _____	35. _____
6. _____	16. _____	26. _____	36. _____
7. _____	17. _____	27. _____	37. _____
8. _____	18. _____	28. _____	38. _____
9. _____	19. _____	29. _____	39. _____
10. _____	20. _____	30. _____	40. _____

CONT. ON BACK? \_\_\_\_\_



# SAMPLE FRACTIONS

CIRCLE APPROPRIATE FRACTIONS AND WRITE # OF EACH IF >ONE. ADD "F" SUFFIX TO CODE FOR FILTERED/DISSOLVED ANALYSES. CONTAINERS ARE UNPRESERVED AND 1-4L CUBITAINERS UNLESS NOTED OTHERWISE.  $\text{Na}_2\text{S}_2\text{O}_3$  SHOULD BE ADDED TO CHLORINATED WATERS FOR ORGANIC ANALYSES.

AC	IN-HOUSE RCRA EP LEACHATE	O	1-2L GLASS, $\text{H}_2\text{SO}_4$ (pH<2) - O & G
AL	60 ML AMBER - ALDICARB	OD	IL GLASS - ODOR
B	NAOH (pH>12) - CYANIDE	R	$\text{HNO}_3$ (pH<2) - RADS
C	CHILLED - CLASSICALS	S	$\text{H}_2\text{SO}_4$ (pH<2) - VAR. CLASSICALS
CL	TEST TUBE, FROZEN - CHLOROPHYLL	SS	60-1000 ML GLASS - SEDS, SOIL, SLUDGE
ED	60 ML AMBER - EDB	SV	60 ML AMBER - SSS - VOLATILES
F	VARIOUS, FROZEN (i.e. TISSUE)	TS	SMALL AMBER, TETRAGLYME - VOLATILES
FL	I.H. FILTERS	UP	1-4L AMBER - PESTICIDES
FM	VARIOUS, FORMALDEHYDE	V	60 ML AMBER - VOLATILES
H	ZN-AC - SULFIDE	W	1-4L AMBER - NVOs
HB	1-4L AMBER - HERBICIDES	X	250 ML AMBER - TOX
M	250 ML LPE, STERILE - MICROB.	Z	$\text{H}_2\text{SO}_4$ (pH=2) - T. PHENOLS
N	$\text{HNO}_3$ (pH<2) - METALS	( )	OTHER:

## STORET NUMBERS AND/OR LIST NAMES

LIST STORET, METHOD CODE, AND DETECTION LIMIT ON EACH LINE AS REQUIRED.

1. _____	11. _____	21. _____
2. _____	12. _____	22. _____
3. _____	13. _____	23. _____
4. _____	14. _____	24. _____
5. _____	15. _____	25. _____
6. _____	16. _____	26. _____
7. _____	17. _____	27. _____
8. _____	18. _____	28. _____
9. _____	19. _____	29. _____
10. _____	20. _____	30. _____

CONTINUED ON BACK? \_\_\_\_\_

Criteria name (optional): \_\_\_\_\_

(sets minimum det. limit requirements) D-4

**APPENDIX E**

**ESE ANALYTICAL LABORATORY  
SAFETY PLAN**

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.  
LABORATORY SAFETY MANUAL

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## SECTION 3-1

### HOUSEKEEPING

Proper care of equipment and working areas is the first step of a safety program. Good housekeeping implies freedom from debris and absence of excess materials. Such conditions promote safety by removal of the source of possible accidents.

#### ARRANGEMENT

Laboratory facilities shall be inspected annually by the Safety Coordinator to ensure compliance with laboratory area criteria outlined in the "Handbook of Analytical Quality Control in Water and Wastewater Laboratories" (EPA, 1979).

A definite storage place shall be provided for each item and the item placed therein when not in use. Such storage areas shall always be neat, clean, and orderly.

Aisles and walkways shall be kept clean, dry, and free of obstructions or tripping hazards.

Arrangement of laboratory equipment shall be planned so that transportation of hot objects or chemicals in glassware is kept to a minimum. When necessary, use tongs and/or heat protective gloves will be used.

When choosing a site for an operation or the storage of materials, consideration shall be given to the toxicity, flammability, fragility and/or the other hazardous properties of the materials being handled.

#### EQUIPMENT

##### Maintenance

Equipment shall not be placed near the edge of the lab bench where there is a possibility of its being struck.

Dirty glassware should be washed promptly and returned to proper storage.

Equipment and working surfaces shall be cleaned frequently to prevent accumulation of dust.

Cracked or chipped glassware shall be disposed of in the proper manner and then replaced. If the item is very expensive or cannot be easily replaced, it should be repaired and all the sharp edges fire-polished.

Drawers and cabinet doors shall be kept closed when not in use.

Functional equipment of all types shall be kept in safe working condition.

#### Operation

Apparatus and reagents, after use, should be returned promptly to their place of storage.

Items for which there may be further need shall be arranged in an orderly manner about the working area. Keep bench tops clean.

#### SPILLS AND LEAKS

Spilled materials whether liquid or solid, corrosive or inert, shall be cleaned up promptly and completely. Spilled corrosive liquids, assumed to be water, have been the cause of numerous chemical burns to laboratory workers; consequently, all liquid spills shall be handled as corrosive unless the material is definitely known to be non-corrosive.

Should the spilled material be flammable, toxic or corrosive, the person involved shall take all precautionary steps necessary to guard against injury to personnel during the cleaning process. All flames in the vicinity shall be extinguished.

Corrosive or toxic materials shall not be placed in the waste cans. Any acidic and basic wastes should be diluted with water. Laboratory supervisor shall be consulted when toxic materials are disposed.

Care shall be exercised so that spills will be cleaned up in the approved manner. Glass fragments shall be swept up immediately and discarded in the prescribed manner.

#### WASTE DISPOSAL

Adequate facilities are supplied for the disposal of waste paper. Paper should not accumulate on the tables or desks.

Packing materials shall be returned to the shipping and receiving clerks for disposal immediately after unpacking.

Acidic or alkaline solutions shall be diluted to less than one molar prior to being discarded in the sinks.

All waste contained in glassware must be disposed of and the glassware must be thoroughly rinsed by the analyst before

delivery to the washroom, since the glassware washer is not aware of the possible hazardous nature of the waste.

Waste solvent will be disposed of in designated waste bottles. These bottles will be placed in the central waste disposal area where the contents will be prepared for pick up by the contracting waste disposal firm.

Toxic and hazardous substances, contained in disposable vessels, or contaminated glassware are to be given to the Safety Coordinator for disposal with other hazardous waste. These wastes will be picked up by the contracting waste disposal firm.

## SECTION 3-2

### SAFETY EQUIPMENT

Safety equipment may be divided into two general classes: first, that used for protection of life or property in case of emergency or unusual happening; and second, that used daily as protection against known and anticipated hazards.

#### EMERGENCY EQUIPMENT/PROCEDURES

No obstruction, even temporary, shall prevent access to this equipment.

A fire alarm shall be turned in immediately if there exists a remote possibility that the fire cannot be extinguished by means of the portable extinguishers at hand.

A fire extinguisher is a device or substance which will cool a flaming material below its ignition temperature, or smother it by exclusion of oxygen, or both. Fire extinguishers of the ABC type shall be in place in laboratories and laboratory hallways. This type of fire extinguisher is also distributed in strategic locations throughout the building facilities. In case of fire, serious damage may be avoided through prompt use of an extinguisher. Best results are obtained when the CO<sub>2</sub> is blown directly on the burning material from a distance of 3 or 4 feet.

An extinguisher which has been used shall not be returned to its bracket but shall be turned over for recharging. All laboratory fires, regardless of size, shall be reported to the supervisor whether an extinguisher is used or not.

Water should not be used on an electrical fire until all electrical power to the burning equipment has been turned off. The best way to remove power if the plug cannot be reached is to turn off the appropriate circuit breaker(s).

Eye wash fountains are available for the irrigation of the eyes should corrosive liquids be splashed therein.

The safety showers should be used without hesitation in the event acid, etc., is spilled on the clothing or skin.

Fire blankets are placed strategically in the laboratory areas for use in the event that personal clothing catches fire.

Self-contained breathing apparatus is provided for protection from hazardous fumes released in a laboratory accident.

Laboratory personnel shall be regularly familiarized with the location and function of laboratory safety equipment.

#### PROTECTIVE EQUIPMENT

This classification covers those items which are used to guard against injury in case of mishap, or for the protection of health. Depending on their frequency of use they may be assigned to the individual, be located at the points of probable need, or be part of a permanent installation.

Laboratory coats or aprons shall be worn by all persons handling chemicals in the laboratory and by such other persons whose activities subject them to hazards due to spills or splashes.

Shoes must be worn at all times in the laboratory. Sandals do not afford adequate foot protection.

Metal carts are provided for transporting laboratory equipment, chemicals, and glassware.

Eye protection is required when working in the laboratory area. Safety glasses are provided and should be worn by personnel who do not normally wear glasses.

Gloves can protect the wearer from many injuries.

1. Heat protective gloves are provided and may be used when handling hot or cold objects.
2. Leather gloves shall be used for handling broken glassware, for inserting glass tubes into rubber stoppers, and for like operations where a firm grasp of a small object is required but where protection from corrosive chemicals is not necessary.
3. Heavy rubber gauntlet gloves shall be used in handling large volumes of corrosive liquids. Care shall be exercised when gloves become wet because rubber is prone to become slippery.
4. Surgical gloves or other light-weight rubber gloves are provided and should be used for protection against toxic irritating, corrosive, or radioactive materials in those operations requiring dexterous use of the fingers.

Hood windows should be lowered for control of fumes and to provide physical protection in operations involving the heating (and where possible other handling) of flammable, corrosive, or potentially explosive materials. A lowered



window shall not be raised until it is established that no hazardous operation is being carried on behind it.

Safety shields are to be used in operations involving possible explosions or flying particles. Some type of shield should be used for distillations in glass which involve appreciable quantities of corrosive materials or flammable solvents, and/or use of vacuum technique. It should also be used for reactions of unknown characteristics or those which may conceivably become explosive or otherwise uncontrollable. The hood window is made of safety glass and is an adequate shield in many cases.

Soap and water, if frequently used on the hands and arms, will remove unsuspected bits of irritation materials.

Step ladders or foot stools shall be used for reaching high objects. Handrails, swivel chairs, piled boxes, or other makeshift devices should not be substituted. Ladders and stools when not in use shall be stored in such a way that they represent no tripping hazard.

### SECTION 3-3

#### SAFE PRACTICES

A study of industrial injuries has shown that the great majority, when classified according to cause, fall within a relatively few categories. From this study it has been possible to develop certain simple, basic rules which, if observed, will materially lessen one's chances of injury.

These rules are intended to assist the laboratory worker in the course of his/her work.

#### PERSONAL

Courses in first aid and cardiopulmonary resuscitation will be offered regularly. Laboratory personnel shall attend these courses.

New work or a new operation is to be attempted only upon direction of supervision and then only after being fully instructed in the method and hazards involved.

All injuries shall be promptly reported to the supervisor.

All hazards shall be reported promptly to the supervisor for proper action.

Running, except in extreme emergency, is not permitted in the laboratory.

Horseplay is not permitted.

Laboratory personnel shall not participate in work activities while intoxicated.

Eating, smoking, or drinking is not permitted in any portion of the laboratory where chemicals are handled. Smoking is not permitted in the laboratory.

Laboratory equipment may not be used as containers for eating or drinking. Coffee cups, etc., should be kept in the place provided and not in the chemistry laboratories.

Laboratory reagents such as sodium chloride shall not be used for food. The potential danger due to error is too serious.

Avoid exposure of the eyes to ultraviolet light or infrared rays.

Suction by mouth (when using pipets, or wash bottles, for example) is not permitted due to chemical hazard. Rubber suction bulbs are to be used.

#### HANDLING AND STORAGE OF MATERIALS

Items on shelves shall be so placed that they will not be jarred off accidentally.

Heavy loads shall not be lifted without adequate assistance.

Milk and soft drink bottles shall not be used for samples or other chemicals.

Protruding nails, wire ends, etc., shall be removed or bent so that they present no hazard to personnel.

When flammable liquids are being transferred from one metal to another, both containers shall be electrically grounded.

Heavy items should be stored as near the floor as possible. Shelves used to support very heavy items should be sufficiently strong.

Apparatus and glass tubing should not project beyond front shelf limits.

Reagents should be grouped judiciously to circumvent dangers of hazardous combinations. Acids and bases shall be stored separately.

Large boxes, etc., should not be stored on the floor of the supply room where they will obstruct access to any of the storage shelves. Aisles shall be kept clear.

Cylinders of gases must be supported to prevent rolling or toppling over, and placed away from heat and open flames. When not in use, the cylinder must also be capped if a regulator is not installed. Tanks of compressed gas can become highly dangerous missiles if damaged.

Many compressed gases are highly toxic and should be stored and used only in well ventilated areas.

Acids and bases above 2N shall be stored in separate lead or plastic trays, adequate to contain the liquid if breakage or spillage should occur. Dilute acids in quantities less than 1 liter may be kept on the reagent shelf, but concentrated acids should be kept in the lead tray under the sink.

Packing material, etc., shall not be permitted to accumulate on the floor of the storeroom or the laboratory. It shall be returned to receiving.

Large containers of acid and base should be carried and poured from protective carriers.

Solvents shall not be stored in the laboratory except in the amounts required for immediate use.

## SECTION 3-4

### LABORATORY PROCEDURES

While there may be more than one way of doing a job, repetition and experience soon teach that one particular method has more desirable qualities and fewer objectionable ones than other methods.

#### GLASSWARE

Broken or chipped glassware shall not be used nor returned to storage. If it is beyond repair, it is to be placed in the broken glass container. When in doubt regarding proper disposal, consult your supervisor.

Broken glass in sinks presents a serious hazard since it may not be visible in the presence of water. When broken in the sink, it shall be removed promptly. Furthermore, it is well to consider the possibility of its presence when reaching into the sink for any purpose.

All broken glassware should be swept up and disposed of immediately and in a safe manner.

Sharp or jagged edges of glassware shall be removed before use. The edges on all Pyrex tubing and/or similar apparatus shall be fire polished.

Combustible or heat sensitive materials of any nature shall be thoroughly cleaned from glass containers before any heating for repairs is attempted. After removal of all visible materials the container shall be thoroughly purged with air to assure the absence of flammable vapors.

Inserting glass tubing into stoppers or rubber tubing is hazardous unless the following precautions are observed:

1. Fire polish the end of all glass tubing.
2. Choose rubber tubing and bore holes in stoppers so that proper fit is obtained. Cork stoppers should be rolled to soften before boring.
3. Lubricate the glass with water or glycerin.
4. Wear leather gloves. Insert the tubing through the stopper using a slight twisting thrust.

5. Pull the tubing whenever possible. Push tubing only when starting through hole.

In some cases it may be convenient to perform steps 1 and 2 alone; then, leaving the cork borer inserted in the stopper, proceed as follows:

6. Insert the glass in the barrel of the cork borer to the depth desired.
7. While wearing leather gloves remove the cork borer with a twisting motion.

Glass or metal tubing shall be inserted entirely through stoppers to assure that the end may not be closed over by heat or solvent action.

To remove glass tubing or thermometers from rubber, it is generally desirable to cut away the rubber. This is particularly true if the tubing or stopper has been in place over an extended period of time, or if it has been subjected to heat.

In handling beakers, support shall be by grasping around the sides, never over the top. If the hand will not reach more than half-way around the beaker, both hands may be used. Large beakers (1 liter or more) should be supported from the bottom when in use.

When heating materials in glass by means of a gas flame, the glass shall be protected from direct contact with the flame through use of a wire gauze.

When placing liquids in bottles which have a positive closure, more than 5 percent of the volume shall be reserved as air space to allow for expansion due to temperature changes.

Frozen stopcocks or ground glass stoppers shall not be forced. Either (1) use a stopcock puller, or (2) if the nature of the contents of the vessel permits, cool the shell until the plug is cold then heat the shell of the joint momentarily. Withdraw the plug quickly before it has been expanded by the heat.

#### VACUUM

Glassware under vacuum shall be protected from physical shock which might cause cracks, resulting in collapse with implosive violence.

Flat bottom flasks shall not be subjected to vacuum unless constructed with heavy walls specifically for such service.

Standard wall (spherical) flasks larger than 1 liter, when used in vacuum service, shall be guarded by a shield that is adequate to stop all flying glass should collapse occur.

Cork or rubber stoppers used in vacuum service shall be carefully chosen to be of such size that they will not be drawn into the opening which they are intended to close.

Vacuum in any system shall be relieved before any attempt is made to disassemble the equipment.

Hot flasks containing uncondensed vapors or steam shall not be stoppered; to do so will subject them to vacuum on cooling.

## ACIDS

Rubber gloves should be worn when handling concentrated acids. (Also see Section 3-2, SAFETY EQUIPMENT.)

When handling concentrated acids in volumes greater than 1 liter, acid goggles, a rubber apron, and rubber gloves shall be worn.

When handling concentrated acids, these general rules should be remembered:

1. Hydrofluoric, perchloric, and sulfurous acids should never be obtained in quantities greater than 1 pound.
2. Splash-proof goggles shall be worn when pouring concentrated acids from the reagent bottles.
3. Rubber gloves should be worn.
4. Pour acids into water when diluting. An exception to this rule may be permitted in the case of hydrochloric or nitric acid as directed by supervision, but never in the case of sulfuric or phosphoric acid.
5. When emptying acids and cleaning solutions into the drains, first fill the sink with water, pour the acid or cleaning solution into the sink and then let the water run out. Allow the tap to remain on full for a few additional minutes. Dilutions should always be sufficient to reduce the acid concentration to less than one normal.
6. If the safety of any operation is doubtful, do not guess; contact supervision.

## BASES

Concentrated ammonium hydroxide and solutions of potassium and sodium hydroxide which are 10N or above shall be treated as if they were concentrated acids and the above rules followed. However, they shall not be stored in the same trays with acids. Concentrated bases should not be stored in glass stoppered bottles or the glass stoppers will freeze in place.

## VOLATILE SOLVENTS

No open flames are permitted in the areas where volatile solvents are used or stored.

Volatile solvents that are immiscible with water shall be retained in approved safety cans labeled "waste solvent." If the solvent contains traces of a corrosive acid (e.g., HCL) the solvent shall be washed with dilute (1N) NaOH solution to neutralize the acid prior to disposal in the safety can.

Store frequently used solvents only in a solvent storage cabinet constructed in accordance with the National Fire Prevention Association guidelines and OSHA requirements.

A separate building should be used for bulk quantities of solvents.

A 1-gallon solvent bottle should be placed in a protective carrier when used.

Flammable liquids should be used only in a properly functioning, periodically-checked fume hood.

Spill trays should be used for materials in breakable containers. The capacity of the spill tray should exceed that of the container it holds.

For good chromatographic practice, aromatics should be separated from other organic solvents.

## MISCELLANEOUS

The cover of the centrifuge shall not be lifted until rotation has stopped. The cover shall be closed when the centrifuge is not in use.

When using a cork borer, the stopper shall not be held in the palm of the hand. Rather, it should be placed large end down on a soft, flat surface and held in place with the thumb and forefinger. The cork borer shall be kept sharp and should be lubricated with water or glycerin to prevent binding. It is not to be forced through the stopper, but rather twisted to



cut the material. The use of leather gloves gives added protection in case of slippage.

Rigidity of equipment assemblies shall be assured by the use of clamping devices.

Permanent standard descriptive labels shall be affixed to all bottles, flasks, or other containers of chemicals even though the contents are harmless.

Furnace and oven doors shall be provided with vents or safety latches which will release readily in case of internal pressure. Volatile, flammable materials shall not be placed in the ovens or furnaces.

Services (air, water, gas, etc.) shall be turned off at the service cock when not in use because changes in pressure may suddenly dislodge the rubber tubing and lead to accident and possible injury.

Stoppers should not be set down while liquids are being poured, but should be held in the approved manner.

Hot plates, etc., although not in evident use, may be hot, and should never be assumed to be cold.

When transporting hot equipment, tongs or heat protective gloves shall be used.

Materials having toxic fumes shall be kept in hoods.

Never connect a gas cylinder regulator that has been used for any gas other than O<sub>2</sub> to an O<sub>2</sub> cylinder.

## SECTION 3-5

### GASES

Laboratory personnel using analytical instrumentation require a variety of gases for proper functioning of equipment. These compressed gases, supplied in steel cylinders, present physical and chemical hazards. The frequency of use and the potential hazards involved require special safety considerations for the handling of compressed gases.

#### GENERAL HANDLING

Compressed gases should be secured with a chain or cylinder stand.

Flammable gases should not be stored with oxidizing gases.

The nature of the contents of the cylinder (i.e., flammable, corrosive, life supportive, poisonous, or cold hazard) should be noted by laboratory personnel.

Traps should be used to prevent back contamination of the cylinder.

Proper regulators should be used with each cylinder. Regulator adapters should never be used.

The main valve should be closed when the cylinder is not being used. The pressure in the regulator should be reduced to atmospheric pressure.

Cylinders should not be stored near sources of heat.

Steel cylinders should never be immersed in liquid nitrogen.

## SECTION 3-6

### CHEMICALS

Many chemicals used in the laboratory are highly toxic and dangerous to use. Violent explosions and rapid decomposition of unstable compounds is an ever-present hazard in the laboratory. A minor change in conditions may convert a mild process to one of violence, i.e., a simple operation conducted in a new manner may involve little known and possibly dangerous reactions. Common chemicals may react in this manner when subjected to wrong conditions. It is, therefore, important to recognize the potentially hazardous properties of the materials being handled, and to know the methods by which these hazards may be minimized.

#### GENERAL HANDLING

All unknown chemicals, reagents, samples, etc., are to be considered hazardous until assurance to the contrary is obtained.

Methods should be followed as outlined. Before undertaking an unfamiliar operation, learn the method of operation and hazards involved. Location of any safety equipment which may possibly be needed should be known. Precautions indicated in analytical procedures should be fully understood and applied.

Stunt experiments are forbidden.

Little known reactions may be encountered in experimental work. Proposed programs should be discussed with the supervisor before attempting development work.

Acids and alkalines in contact with skin will cause burns which vary in severity with the strength of the solution, the time of contact, and the tenderness of the part affected. Should they be spilled on the body, they should be promptly washed with large amounts of water.

Acids (see Section 3-4).

Flammable liquids (see Section 3-4).

When opening bottles containing dissolved gases ( $\text{NH}_4\text{OH}$ ,  $\text{HCL}$ , etc.) or ampoules of liquids of high vapor pressure ( $\text{Br}_2$ , acetyl chloride, etc.), care shall be taken that the eyes are protected from any possible liquid spray.

1. In no case shall the container be opened when the contents are above room temperature.

2. Screw caps on standard 5-pint bottles, if opened cautiously, will tend to give some protection by directing any spray downward.
3. Glass stoppers, once removed, will generally, but not always, relieve any pressure by permitting gas leakage. Therefore, when using such bottles, (including shelf reagents) the bottle should be held well away from the face while removing the stopper.

Suction by mouth (when using pipets or wash bottles, for example) is not permitted due to the chemical and radioactive hazards. Vacuum system or rubber suction bulbs are to be used.

Testing for odor of unknown materials should be done cautiously and always with the lungs full in order that unpleasant fumes may be expelled promptly. Preliminary tests should be made by wafting the fumes by hand motion from the open container toward the nose.

Fumes of any variety may be toxic or may produce unpleasant results if breathed in sufficient concentration or over extended periods of time. Therefore, any reaction which involves the evolution of fumes should be carried out with due consideration given to adequate ventilation. In cases where hazardous gases are released, the operation shall be carried out in the hood.

Corrosive, toxic, hot, or flammable liquids used in large volume in any operation shall be so guarded that equipment failure will not lead to danger to personnel.

Spilled chemicals shall be cleaned up immediately. (See Section 3-1.)

Many organic solvents boil at low temperatures. Care shall be taken to store such items at temperatures well below their boiling points.

Volatile solvents, when shaken in separatory funnels, may develop considerable pressure. Rupture with explosive violence may be avoided by frequent removal of the stopper or by opening the stopcock when the funnel is inverted.

Strongly corrosive liquids shall be handled only in areas where ample water is available. The safety shower should be used if necessary.

Corrosive liquids in glass should be kept below eye level at all times during handling or storage, except that the reagent

shelf is considered satisfactory for bottles of 1-liter capacity or less.

Droplets of corrosive liquids on the side of bottles after pouring shall be removed before the bottle is returned to storage.

Liquified gases shall not be placed in any container which can be accidentally sealed.

Materials capable of liberating poisonous or flammable gases in appreciable amounts shall not be emptied into the drains and sewers.

Chemicals which might react together to produce dangerous fumes, fire, or explosion shall not be stored adjacent to one another.

Oxidizing agents (e.g., perchloric acid and bromine) in contact with organic and other reducing substances may produce violent reactions, fire, or explosion. They may be so used only in certain specific instances under direct supervision.

Organic materials in contact with the skin may have unpredictable effects. Severe cases of dermatitis have at times been traced to chemicals by which other people were unaffected.

#### SPECIFIC HAZARDS

For specific chemicals not listed here, refer to the "Merck Index."

Acetic acid can cause burns if spilled or splashed on the skin. It penetrates the skin easily and can cause dermatitis and ulcers. Affected areas should be washed with water immediately. Acetic acid is particularly dangerous in contact with chromic acid, sodium peroxide, or nitric acid.

Amino compounds may cause serious illness if the vapors are inhaled or if the liquid is allowed to contact the skin. Some aminos are highly toxic, others are only slightly toxic.

Ammonium hydroxide is corrosive and will cause burns if spilled or splashed on the skin. Affected areas should be immediately flushed with large amounts of water. Vapors are irritating to the eyes and mucous membranes. The chemical should be used only in a well-ventilated area. Ammonium hydroxide forms explosive compounds with several substances such as mercury, silver, and iodine. Ammoniacal silver nitrate shall never be kept on hand, even in small quantities for more than a few hours. Waste materials should be neutralized with acid prior to disposal.

Arsenic, antimony, and their compounds are toxic. Ingestion of small quantities may result in death.

Barium compounds and the compounds of the heavy metals are extremely poisonous. Among these are the salts of cadmium, copper, lead, molybdenum, and beryllium.

Benzene is flammable and toxic if the vapors are inhaled or if the liquid is spilled on the skin. The reagent is to be dispensed only in a well-ventilated area.

Bromine is extremely poisonous and corrosive. Even the vapors will produce burns to the skin. All handling of liquid bromine shall be carried out in a well-ventilated area.

Brucine is an extremely toxic substance. Ingestion of small quantities may result in death.

Carbon disulfide, while toxic, is most hazardous due to its high flammability. Its vapors are explosive in air in the range of 1.25 to 50 percent by volume, and it ignites spontaneously at about 425°C. Thus, the heat of a hot plate or even a light bulb may easily ignite the vapors. Carbon disulfide shall be used in a flame-free hood.

Chlorates and perchlorates (perchloric acid) may produce violent explosions when in contact with organic or other reducing materials. They are to be used in this laboratory only upon specific authorization and direction.

Chloroform is toxic if inhaled, and contact with the skin should be avoided since absorption through the pores may produce the same physiological effects as inhalation. Excessive dryness with subsequent cracking of the skin may also result from contact. Gloves should be worn and chloroform should be used only in a well-ventilated area. Chloroform is not flammable and is not explosive.

Chlorine, see "Halogens."

Chromic acid and chromates are strong oxidizing agents, and many organic materials will be ignited upon contact with them.

Cyanides, cyanogen, and hydrocyanic acid (prussic acid) are extremely toxic. Death is almost immediate if taken internally or if inhaled. They should not be stored or mixed with acid solution.

Dry ice, like liquid air and other liquified gases, shall never be placed in a container which can be accidentally

sealed. It also causes severe frostbite on the skin and shall therefore be handled with heavy gloves or tongs.

Ethers, in storage, have a tendency to form peroxides, which are explosive if heated. No ethers should be distilled or otherwise evaporated to dryness unless analysis shows the peroxide content, as hydrogen peroxide, to be not greater than 0.10 percent.

Ethyl acetate is a dangerous fire hazard and should be used only in a flame-free hood. It is irritating to mucous surfaces, particularly the eyes, gums, and respiratory passages. Repeated or prolonged exposures may cause serious irritations. Surgical gloves are required when handling.

Fluorine, fluorides, and hydrofluoric acid are extremely poisonous. The halogen and the acid are quite corrosive and in contact with the skin yield slow-healing sores. Hydrofluoric acid should not be stored in glass bottles.

Halogens (chlorine, fluorine, bromine) and halogen acids are corrosive. Vapors are irritating to the membranes of the respiratory system as well as the flesh.

Hydrochloric acid, see "Halogens and halogen acids."

Hydrofluoric acid, see "Fluorine."

Hydrogen peroxide, on standing, tends to decompose with evolution of gas.

Hydrogen sulfide is extremely poisonous even in trace amounts. All reactions involving this gas shall be carried out in a well-ventilated area.

Mercury is hazardous chiefly through the possibility of inhaling the vapors. Its vapor pressure is appreciable even at room temperature (equivalent to 0.04 mg/l at 30°C) and toxic quantities are probable under unfavorable conditions. Safety may be assured by adequate ventilation, by cleaning up spilled mercury promptly, and by maintaining a minimum of unstopped containers. Compounds of mercury are extremely toxic; hands should be washed thoroughly after handling them (see Ammonium Hydroxide).

Methyl alcohol is extremely toxic and may lead to blindness or death if taken into the digestive or respiratory systems or if absorbed through the skin. Its effect varies somewhat among individuals.

Methyl ethyl ketone is a flammable liquid and a dangerous fire hazard (see Section 3-4, LABORATORY PROCEDURES).

Nitric acid, on contact with many organic materials, may lead to fire or explosion. It may only be used to remove organic materials as directed by the analytical procedures or by your supervisor. Nitric acid is extremely corrosive to the flesh, and its fumes are highly irritating to the mucous membranes of the eyes and respiratory tract.

Oxalic acid and its salts have a caustic action on the skin and on the internal organs if swallowed. When ingested in large quantities, death may follow quickly.

Ozone is produced by the discharge of a high potential voltage in air. It may be encountered when operating certain instruments. The MAC for ozone in the air (8-hour work day) is 0.1 ppm. Exposure to 1 ppm for short periods will produce dryness of the eyes and respiratory tract and headache. Exposure to 1 ppm for extended periods of time or higher concentrations for a shorter period may result in severe or even fatal injury to the lungs. Ozone has a characteristic odor that can be detected by smell when the concentration exceeds 0.015 ppm. When the odor of ozone is noticeable, leave the area or discontinue the operation of the equipment that is producing the ozone until the concentration can be determined and/or adequate ventilation established.

Perchloric acid has a tremendous potential destructive power and should be handled with utmost caution. When handling perchloric acid, protective rubber gloves, aprons, and a face shield or anti-splash goggles should be worn. One drop of perchloric acid splashed on the eye will almost certainly cause the loss of that eye. Perchloric acid is a strong oxidant, and extreme care shall be exercised when using it to destroy traces of organic material. Organic material, e.g., paper towels, containing even one drop of perchloric acid shall not be disposed of in waste containers until the material has been thoroughly flushed with water to dilute and remove the perchloric acid. Discolored acid, which means that it is contaminated with organic or inorganic material, should be disposed of immediately. Bottles of perchloric acid should be kept on a glass or porcelain (unchipped) tray.

Perchloroethylene is toxic when inhaled, ingested, or following prolonged or repeated contact with the skin.

Peroxides are strong oxidizing agents. They may be used only in certain specified instances. Organic peroxides are highly explosive (see "Ethers").

Phosphoric acid is highly corrosive and will cause painful burns upon contact with the skin. Affected areas should be immediately washed with water. The acid generates



considerable heat upon addition to water and mixing shall therefore be carried in a Pyrex vessel. Always pour the concentrated acid into the water, never the reverse.

Potassium hydroxide and its solution are extremely corrosive. Solution of the solid in water liberates considerable heat, and mixing shall therefore be carried out with care in Pyrex or metal containers.

Silver nitrate is toxic if taken internally. On contact with the skin, the salt or its solution cause skin discolorations. Flush affected parts immediately with large amounts of water.

Sodium hydroxide, see "Potassium hydroxide."

Sulfurous acid fumes (or sulfur dioxide) are highly toxic. Concentrations as low as 0.3 to 1 ppm can be detected by the average individual by taste, rather than the sense of smell. Work with sulfurous acid should be done in a hood.

Sulfuric acid is highly corrosive and will cause painful burns upon contact with the skin. Affected areas should be immediately washed with water. The acid generates considerable heat upon addition to water, and mixing shall be performed slowly in a Pyrex vessel. The concentrated acid should always be poured into water, never the reverse.

Toluene is flammable, and the vapors are moderately toxic (see Section 3-4).

Trichlorethylene is moderately toxic when the vapors are inhaled or the liquid is spilled on the skin.

Avoid breathing and skin contact with organic solvents. Many solvents are more toxic than is generally thought.

Heated mixtures of concentrated perchloric acid and organic matter may explode violently. Avoid this hazard by taking the following precautions: (1) Do not add perchloric acid to a hot solution that may contain organic matter. (2) Always pretreat samples containing organic matter with  $\text{HNO}_3$  prior to addition of  $\text{HClO}_4$ . (3) Use a mixture of nitric and perchloric acids in starting the digestion step. (4) Avoid repeated fumings with perchloric acid in ordinary hoods. For work with perchloric acid, connect a water pump to a glass fume eradicator.

## SECTION 3-7

### CHEMICAL CARCINOGENS

Chemical carcinogens are those chemicals which are suspected to have the potential for inducing cancer in man and other mammals. It is necessary, therefore, to establish and enforce strict procedures for the safe handling of these substances. The approach that will be taken is to severely restrict access and handling of these substances in concentrations greater than 0.1 percent. The U.S. Department of Labor considers normal laboratory safety precautions adequate for handling concentrations less than 0.1 percent.

#### CONTROL OF CHEMICAL CARCINOGENS

A senior chemist shall be appointed the responsibility for the absolute control of all chemical carcinogens.

The appointed Control Officer shall be responsible for strict adherence to the U.S. Department of Health, Education and Welfare Safety Standards for Laboratory Operations Involving Chemical Carcinogens. He/she shall keep abreast of changes to this and other related standards.

The Control Officer is responsible for identification, storage, and inventory of all carcinogenic substances.

Storage vessels containing chemical carcinogens shall be labeled:

DANGER--CHEMICAL CARCINOGEN.

An inventory of all chemical carcinogens shall be maintained by the Control Officer. The inventory records shall include the quantities of chemical carcinogens acquired, dates of acquisition, and disposition.

An unbreakable outer container shall be used to transport chemical carcinogens.

Materials contaminated with chemical carcinogens which are transferred from work areas to disposal areas shall be placed into separate closed plastic bags or other suitable impermeable and sealed containers for each carcinogen, which are labeled with both the name of the carcinogen and DANGER--CHEMICAL CARCINOGEN before being transported.

The Control Officer alone shall be responsible for all handling of carcinogenic materials in the concentrated form and shall prepare all dilute solutions for laboratory use adhering to the prescribed precautions.

The Control Officer shall maintain a posted list in the laboratory of all substances falling into the category of chemical carcinogen.

#### HANDLING OF DILUTE SOLUTIONS OF CHEMICAL CARCINOGENS

Each person shall meticulously exercise normal laboratory safety procedures as enumerated in this manual while handling dilute (less than 0.1 percent) solutions of chemical carcinogens.

## SECTION 3-8

### RADIOLOGICAL SAFETY PROCEDURES

#### STORAGE AND HANDLING

All radioactive materials should be stored in specially designated areas.

All work with these materials should be carried out only in authorized areas.

Eating, drinking, smoking, and the use of cosmetics in the laboratory are not permitted.

Pipetting or the performance of any similar operation should not be done by mouth suction.

#### LABORATORY PROCEDURES

Before a worker leaves the laboratory, the hands should be washed, then checked with a beta-gamma survey meter. Contamination remaining after thorough washing should be reported.

If, in the course of work, personal contamination is suspected, a survey with a suitable instrument should be made immediately. This should be followed by the required cleansing and a further survey. Routine precautionary surveys should be made at intervals.

No person should work with active materials if he/she has any breaks in the skin on the hands unless rubber gloves are worn.

No person should work in the laboratory without wearing a personal dosimeter.

All wounds, spills, and other emergencies should be reported to the supervisor immediately.

#### WASTE DISPOSAL

Active liquid wastes should be poured into the labeled containers provided. They should never be poured into a standard drain.

Active solid wastes and contaminated materials should be placed in trash cans labeled "contaminated" or in designated containers.

Good housekeeping is encouraged at all times. Spillage should be prevented, but in the event of such an accident, the following procedure should be followed:

1. The liquid should be blotted up. (Wear rubber gloves.)
2. All disposable materials contaminated by the spill and the cleaning process should be placed in a "contaminated" trash can.
3. The area of the spill and the type of activity (e.g., iodine-131) should be clearly marked.

No apparatus should be washed in the public water-sewage system if it contains any activity appreciably above background when measured with a counter-type survey meter.

In general, active materials and contaminated materials are to be retained within the radioisotope laboratory and at specific points within the laboratory.

## SECTION 3-9

### REFERENCES

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